The Polysemy and Hyponymy of Mandarin Spatial Prepositions and Localisers: Building Semantic Maps from the Ground up

Francesco-Alessio Ursini1*, Qi Rao1,2,3* and Yue Sara Zhang4*

1School of Chinese Language and Literature, Central China Normal University, Wuhan, China, 2National Language Resources Monitoring and Research Center (CNLR) Network Media Branch, Wuhan, China, 3Key Laboratory of Computational Linguistics (Peking University), Ministry of Education, Beijing, China, 4School of Foreign Languages, Sun Yat-sen University, Guangzhou, China

The goal of this paper is to offer an overview of polysemy patterns in Mandarin’s chief spatial categories: prepositions (e.g., zai) and simple and compound localisers (respectively, qian and qian-mian). The paper presents data from an elicitation study that shows how speakers can access multiple senses and hyponymy relations for the vocabulary items belonging to these categories. The paper shows that while prepositions can potentially cover different spatial relations in the opportune context (e.g., zai “at”), localisers select increasingly specific senses (e.g., qian “front” and qian-mian “front side”). The paper also shows how speakers can access hyponym-like sense relations emerging from these patterns (e.g., qian-bian covering a more specific sense than qian). Semantic dimensions such as “distance” and “location type” determine the strength of these hyponymy relations. The paper offers an account of these data based on the “semantics maps” model, which captures polysemy and hyponymy patterns via the clusters of locations they refer to. It is shown that this novel model is consistent with previous works on the polysemy of spatial categories and sheds light on how Mandarin offers a unique organisation of this domain.

Keywords: polysemy, hyponymy, mandarin, prepositions, localisers, semantic maps

INTRODUCTION

Polysemy is usually defined as the ability of a vocabulary item to cover distinct but related senses (Apresjan 1974). The nature of polysemy is still the topic of intense debate. Some proposals suggest that polysemy is a pragmatic phenomenon based on speakers’ use of language in context (e.g., Falkum 2011, 2015, 2017). Other proposals suggest that polysemy is a reflection of the rich semantic content of lexical categories (e.g., Pustejovsky 1995; Asher 2011; Evans 2015). Yet other proposals offer intermediate positions attempting to integrate semantic and pragmatic views into coherent
models with conceptual underpinnings (e.g., Tyler and Evans 2003). Polysemy therefore presents at least two challenges for linguistic theories. The first is establishing whether this phenomenon is semantic or pragmatic (or both) in nature. The second is establishing whether and how it can emerge across grammatical/functional categories.

The language we analyse in this paper is Mandarin, which we choose for two key reasons. First, Mandarin includes two related categories conveying multiple spatial senses: prepositions and fangweici, or "localisers" (e.g., respectively, zai and qian in zai zhuzi qian "in front of the desk"). Second, most works document the polysemy of these categories as involving different sense types. They show that spatial prepositions and localisers can also have temporal senses (e.g., zai siyue "in April" and wuye qian "before midnight"), and other non-spatial senses (Huang et al., 2017: Appendix VII). However, little is known about the possibility that these categories can cover distinct spatial senses. For instance, the English preposition on can cover at least two distinct senses: "support" (e.g., a book on the table) and "attachment" (e.g., a painting on the wall: Tyler and Evans 2003: Ch. 4). However, this type of polysemy appears understudied in Mandarin, as we can illustrate via 1)–4):

1) Zhangsan zuo zai zhuzi qian
   Zhangsan sit z desk q
   "Zhangsan sits in front of the desk."

2) Zhangsan zai Beijing
   Zhangsan z Beijing
   a. "Zhangsan is in Beijing."
   b. "Zhangsan is near Beijing."
   c. "Zhangsan is North of Beijing."

3) Zhangsan zai Beijing bei/*de bei
   Zhangsan z Beijing north/DE north
   "Zhangsan is North of Beijing."

4) Zhangsan zai Beijing de bei-bian
   Zhangsan z Beijing de north side
   "Zhangsan is in the Northern side of Beijing."

We first introduce some basic descriptive notions. In 1)–4), Zhangsan is a subject noun phrase (NP) denoting a figure referent, i.e., a referent located with respect to a landmark object, or ground referent (Talmy 2000: Ch. 1; Kibrik 2013: Ch. 1). Zai is a preposition in 1), i.e., a functional head possibly introducing the argument of a lexical verb (e.g., zuo "sit": Zhang 2017). In 2)–4), zai acts as a co-verb, a copula-like light verb taking figure and ground NPs as its arguments (e.g., Chao 1968). In 1), the localiser qian "in front" follows the ground NP as a necessary constituent specifying a location under discussion. In 2), the place name Beijing can however license the omission of a localiser (cf. Huang 2009; Zhang 2017). Localisers come in two morphological types. Simple localisers are single morphemes that can refer to one or more related locations (e.g., qian "front"). Compound localisers involve the suffixation of simple localisers with nouns referring to specific location types (e.g., bei-bian "North-side" in 4): Huang et al., 2017: 194). Compound localisers usually follow the relational head de (cf. 4)); simple localisers cannot follow this head (cf. the ungrammatical "de bei in 3").

These sentences encapsulate the following polysemy patterns. In 2), Zhangsan is understood to be in some location related to Beijing, and this location may be "in," or "near," or even "North" of Beijing. In 3), Zhangsan is in a location north of Beijing: the localiser bei refers to this "cardinal" location. In 4), the compound localiser bei-bian establishes a reference to a Northern side of Beijing as a location that Zhangsan occupies. Thus, zai seems to potentially cover a range of spatial senses, each referring to distinct locations related to Beijing: it seems a polysemous preposition. Instead, bei and bei-bian select more specific sense ranges and seem to enter hyponym-like ("type-of") relations with zai. These polysemy patterns and the related hyponymy relations, however, appear understudied in Mandarin spatial categories.

The goal of this paper is therefore threefold. First, we offer an overview of polysemy and hyponymy patterns holding among Mandarin prepositions and localisers and how they are related to their grammatical properties. Second, we show that these properties display nuanced intra-speaker patterns, mediated via the semantic dimensions defining spatial senses. Third, we offer a theoretical account based on our novel interpretation of the "semantic maps" model. When items from different categories enter hyponym relations, we contend that the context must confirm their semantic "relatedness". We suggest that such a multi-domain view of polysemy can be captured via our novel semantic maps model, in which localisers and prepositions refer to possibly overlapping regions of space.

The paper is organised as follows. Previous Literature presents previous literature and motivates our study. Methodology and Results present an elicitation study and the results. A Semantic Account of the Data and General Discussion offer a semantic maps model and a discussion; Conclusion concludes.

PREVIOUS LITERATURE

Our goal in this section is to first offer a concise overview of polysemy and the theoretical views on polysemy types (Theories of Polysemy). We then offer an overview of the grammatical properties of Mandarin prepositions and localisers and extant analyses of their polysemy, thus outlining the explananda we aim to address (The Grammar of Mandarin Spatial Categories and The Polysemy of Mandarin Spatial Categories: Previous Studies).

Theories of Polysemy

Several works have developed distinct but conceptually overlapping views of polysemy (Apresjan 1974; Geeraerts 1993, 2010; Ch. 2; Pustejovsky 1991, 1995, 1998; Cruse 2004: Ch. 6; Murphy 2010, Ch. 3; Riemer 2005; Glynn 2012, 2014, 2016; Falkum and Vicente 2015; Dölling 2020). A relatively general consensus exists on the classification of polysemy into three subtypes: regular or inherent polysemy, irregular polysemy, and...
logical polysemy. Regular polysemy holds when a vocabulary item \( a \) has several senses (e.g., \( s \) and \( s' \)) that can also be expressed via vocabulary items \( b \), \( c \). For instance, *parent* can be considered polysemous because *mother* and *father* capture two of its possible senses (i.e., “female parent” and “male parent”, respectively). Irregular polysemy involves the emergence of “novel” senses via processes of metaphor and metonymy, e.g., temporal senses in prepositions (e.g., *at five o’clock*; Haspelmath 1997; Vicente 2018). Logical polysemy holds when an item’s senses form mutually exclusive sense types. For instance, *lunch* can describe a process (e.g., *lunch took forever*) and a physical entity, i.e., what one eats (e.g., *lunch was delicious*; Pustejovsky 1995; Asher 2011: Ch. 4).

Polysemy is usually defined in opposition to other semantic properties: homonymy, monoeseomy, vagueness, and underspecification (e.g., Ruhl 1989; Kearns 2006; Kennedy 2007; Egg 2011). Aside from monosemy, these other properties will not play a relevant role in our discussion. Hence, we can leave them aside. Most works propose that polysemy can be evaluated via the definition, co-predication, ellipsis, and coordination tests (e.g., Kearns 2006; Asher 2011, Ch. 4; Falkum and Vicente 2015; Vicente 2018; Ortega 2020; Murphy 2021). For our purposes, the definition and the coordination tests play a key role and can be defined as follows. According to the definition test, if the senses \( s \), \( s' \) of a vocabulary item \( a \) involve overlapping but distinct definitions to capture their use in the extra-linguistic context, then the item is polysemous (cf. Tyler and Evans 2003: Ch. 2; and our discussion of 1–4). In the coordination test, a vocabulary item heads two conjoined arguments (e.g., *Zhangsan plays ping-pong and the piano*). Consequently, the two distinct senses can coexist in a coordinated phrase. We will fully illustrate their use in our study in Methodology and Results.

Polysemy is also connected to hierarchical sense relations, possibly defined via hyponymy relations (cf. Apresjan 1974; Cruse 2004: Ch. 6; Murphy 2010: Ch. 3; Bjelobaba 2018). A lexical typology study offering evidence on this matter is Levinson and Meira (2003). This study offers a hierarchical model of increasingly specific spatial concepts to account lexicalisation patterns involving spatial senses. Languages can lexicalise at least the general concept of location *AT* and may lexicalise more specific concepts such as *IN*, *INSIDE*, and *UP*. This increasing element of specificity establishes that, e.g., *IN* acts as a superordinate concept to *INSIDE*. Thus, languages that have two distinct vocabulary items for the *INSIDE* and the *IN* concepts will also include a hyponymy relation between the items. Case in point, the English *inside* can be understood as describing a more specific type of “inclusion” relation than *in*. Thus, *inside* is a hyponym of *in*, according to this analysis.

These notions apply to our discussion of Mandarin, as follows. Our initial examples in 1–4) show that the regular polysemy in prepositions and localisers is still understudied. Crucially, the use of the definition test can offer evidence regarding this type of polysemy and its emergence in an extra-linguistic context. Furthermore, if *zai* can refer to any location, a simple localiser such as *bei* can be a hyponym of *zai* referring to any northern location. The compound hyponym *bei-bian* can then be defined as a hyponym of *bei* and *zai*: it refers to a northern side or region and thus a more specific type of location. Crucially, it is generally assumed that hyponym relations hold only among members of the same category (cf. Cruse 2004: Ch. 5; Murphy 2010: Ch. 4). Whether and how hyponym relations can involve distinct categories seem an open matter. Therefore, the nature of polysemy and hyponymy in prepositions and localisers can be fully analysed only once we address their grammatical properties.

### The Grammar of Mandarin Spatial Categories

Mandarin spatial prepositions and their dual role as co-verbs have been amply discussed (Chao 1968; Li and Thompson 1974, 1981: 381–387; Peyraube 1980; Yin 2003; Lü 2006; Huang 2009; Basciano 2010; 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 prepositions is in 5) (cf. Djamouri et al., 2013):

5) Prepositions := \{ *zai “at,” dao “to,” cong “from,” dang “at,” dui “in the opposite direction of,” li “away,” wang “in the direction of,” xiang “in the direction of” \}

Some previous works have also suggested that *zai* and other spatial prepositions can combine with bare ground NPs only when these NPs act as place names, i.e., proper names for distinctive locations (e.g., *Beijing*; Huang 2009; Huang et al., 2017: 171). In the opportune context, however, any NP can refer to a unique, salient location in context (e.g., *Pitt Street, the main square*; Anderson 2007: Ch. 4; Köhnlein 2015). This is also possible in Mandarin: for instance, speakers can use the preposition and ground NP *zai shufang* “at/in the study room” to refer to a salient location (cf. Lü 1980, 2006; for a similar point). Thus, spatial prepositions may occur without localisers when they take a salient, specific ground NP as their argument.

Simple localisers form a slightly broader set: more than 80 items are listed in Huang et al. (2017: Appendix VII). Nevertheless, most works consider the monosyllabic items in 6) the most representative list for this category (Djamouri et al., 2013: 72; Huang et al., 2017: 217; Zhang 2017: 2). For this reason, they form the bulk of our analysis:

6) (Simple) Localisers := \{ *li “in,” wai “out,” shang “on, above,” xia “down, below,” qian “front,” hou “behind,” zuo “left,” you “right,” bei “North,” xi “West,” dong “East,” nan “South” \}

Compound localisers (e.g., *li-mian* and *wai-bian*) are generally formed via suffixation and prefixation of simple localisers (e.g., Peyraube 1994, 2003; Chappell and Peyraube 2008; Huang et al., 2017: 189–194). Five well-established suffixes are -*mian* “side, face”, -*bian* “side”, -*bu* “part”, -*tou* “head”, and -*fang* “direction, axis”. These are originally independent spatial nouns (“place
nouns” in Huang et al., 2017). In localisers, they occur as suffixes to simple localisers, thus forming compound localisers that refer to highly specific locations.2

Compound localisers can also involve prefixation. Two documented prefixes are zhi- and yi-. These prefixes usually attach to localisers to restrict their sense to a “distant” location. Yi- is mostly used to measure distances. One example is the zuo shan de gau du zai 2000 mi yi-shang (“the mountain’s height is 2000 m”: Huang et al., 2017: Appendix VII). Zhi- has a broader distribution, although the senses it selects display subtle properties and tend to emerge in specific contexts. If shang covers senses approximated via the glosses “on, on top, above”, then zhi-shang seems to only covers the “above” sense. Thus, compound localisers can involve either form of affixation, even though certain restrictions emerge.

The syntactic status of localisers has been amply debated. Several works suggest that localisers are postpositions, i.e., adpositions following a ground NP (Tai 1973; Hagège 1975; Djamouri et al., 2013; Wu 2015). Some works further propose that localisers form a discontinuous circumposition with prepositions (e.g., Chao 1968; Li and Thompson 1974, 1981). Recent works however show that localisers display properties typical of nominal clitics (Liu 1994, 1998; Huang et al., 2009; Lin 2013; Huang et al., 2017; Zhang 2012, 2017; Ursini and Long, 2018; Ursini et al., 2020; Ursini and Huang, 2020). Several syntactic tests also show that localisers form a single unit with ground NPs. One is based on locative inversion, a form of fronting for prepositional phrases (PPs: den Dikken 2006: Ch. 3). Another is based on you- constructions, roughly equivalent to the English there- constructions. We show a case of inversion in 7) and a case of you- construction in 8):

7) Zai che qian Zhangsan chouzhe yi zhi yan z car q Zhangsan smoke cl cigarette.
   “In front of the car, Zhangsan smokes a cigarette.”

8) Zai zhuozi de xia-mian you yi ge qiu z table de x façade there cl ball
   “There is one ball under the table.”

From 7)–8) and 1)–4), we can conclude that prepositions and localisers display a degree of categorical flexibility. Prepositions introduce a ground NP and possibly a localiser as arguments of a verb or may act as co-verbs. Simple localisers act as modifiers to the ground NP and specify which location is involved in the relation between ground and figure. Compound localisers act as arguments of de, thus becoming modifiers to the ground NP. Therefore, prepositions and localisers can combine with ground NPs to form full PPs.

These initial examples also show that prepositions seem to contribute two types of senses to a sentence’s interpretation. First, they can capture either a locative (e.g., zai) or directional relation (e.g., dao) between figure and ground. We define directional relations as relations in which the figure changes location over time. Locative relations describe a figure’s static position over time instead (Jackendoff 1983, 1990; Wunderlich 1991, 1993; Lestrade 2010). Second, localisers seem to refer to a cluster of possible locations that the figure can occupy. Prepositions can also refer to these locations, if localisers are absent from sentences. However, this seems possible insofar as the context offers a cue on which location is under discussion.

Three questions thus arise, which are related to the goals outlined in the Introduction. The first question is how these forms of regular polysemy interact: how the presence of localisers determines which senses of a preposition are selected in a context. The second question is whether this interaction can confirm the existence of hyponym-like relations connecting the two categories. The third question is whether and how these patterns are context-sensitive and therefore can co-occur with speakers’ intuitions about prepositions and localisers’ senses. The next step is to verify whether answers to these questions exist in the literature.

The Polysemy and Spatial Categories: Previous Studies

Most studies addressing spatial categories in Mandarin seem to offer a fragmented view regarding their putative polysemy. Reference grammars and lexicographic sources generally agree that prepositions and localisers can cover several related senses (Chao 1968; Li and Thompson 1981; Sun 2006; Huang et al., 2009, 2017; Appendix VII). However, these works mostly report forms of logical polysemy, e.g., the fact that zai can also cover temporal senses. Recent analyses of zai and cong (Peng 2012) and zai-related constructions (Zhang et al., 2016) show that these prepositions can also cover metaphorical and causal sense types. They therefore offer evidence that the logical polysemy of this preposition has emerged over time (i.e., it starts as a form of irregular polysemy). However, they gloss over the possibility that zai and other prepositions can display forms of regular polysemy as the one discussed via 1)–4). Thus, this polysemy type is understudied, in Mandarin prepositions.

A similar fragmented view exists for localisers. For instance, Lin (2013) observes that pairs such as qian and qian-mian involve forms of sense restriction obtained via suffixation. Wu (2008) discusses hou and how this localiser also captures temporal and causal senses. Similar works offer evidence regarding xia “down”, qian “front”, and hou “back” (Lù 1980; Scott 1989; Xing 1996; Lan 1999; Wu and Muchiñe, 2018). These works analyse in detail the possible sense types associated with these localisers but do not analyse their spatial senses. For instance, Wu (2008) discusses the possible use of hou as a temporal localiser capturing a “before” sense. However, it does not address the senses associated with its suffixed forms (e.g., hou-mian and hou-bian) and whether and how they display forms of polysemy. More in general, these works offer evidence for the logical polysemy of specific localisers but do not address the possibility that localisers can display forms of regular polysemy. Hence, they also leave aside the possibility that prepositions and localisers may enter hyponymy relations, across and within categories (e.g., respectively, zai with bei and bei with bei-bian).

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2 This work also observes that -bu is usually reserved for written texts, so that compound localisers based on this suffix can be considered as belonging to a “formal” register. Since the study we present in Methodology and Results was based on a written text, this dimension does not play a key difference in the overall analysis.
Another proposal is outlined in Tai (1989, 1993, 2005), which extends the “Conceptual Semantics” framework to Mandarin (Jackendoff 1983, 1990). These works propose that Mandarin prepositions and localisers respectively denote the conceptual functions PATH and PLACE-FUNCTION. Tai (1993, 2005) proposes that spatial nouns occurring in de- phrases realise a type of genitive phrase and thus select a sub-type of PLACE-FUNCTION. For instance, while li is treated as denoting the IN function, li-tou is treated as denoting the INSIDE sub-type of function (Tai 1993: 20; cf. also Tai 1975, 1976). Thus, these works hint at the existence of hyponymy relations holding among Mandarin prepositions and localisers, as a logical consequence of their regular polysemy. However, they leave a full analysis for future research. More in general, what is still missing in the literature is an analysis of the regular polysemy of prepositions and localisers and the hyponymy relations potentially emerging from these patterns. Our three questions must therefore still meet their respective answers. The next two sections present the methodology and results that permit us to offer these answers.

**METHODOLOGY**

**Task Selection**

Our study was based on an elicitation task. We chose this task over the collection of corpus data, the favoured method in studies on polysemy (e.g., Tyler and Evans 2003; Deignan 2005, 2014; Glynn 2016). Our choice was motivated by practical reasons. To test whether two items belonging to the same category stand in a hyponymy relation (e.g., apple and fruit), one must query corpora and find sentences explicitly stating such relations (e.g., an apple is a kind of fruit: Glynn 2012). However, the feasibility of this approach appears low if one wishes to investigate categories other than nouns and verbs (i.e., lexical categories). Mandarin prepositions and localisers are equivalent to functional categories (e.g., Huang et al., 2017). Furthermore, testing hyponymy relations holding among their items entails testing relations among subtly different categories. Therefore, a different task seems necessary for our goals.

Elicitation tasks can avoid this problem for two reasons. First, experimenters can create novel sentences including the target categories and vocabulary items that easily lend themselves to the testing of a given hypothesis. Second, experimenters can carefully control the extra-linguistic contexts in which participants evaluate these sentences. For instance, in the “Topographic Relation Picture Series”, participants are asked to describe pictures from a series representing one of 71 topographic relations (e.g., “support”, “attachment”, and “inclusion”: Bowerman and Pederson, 1992; Bowerman, 1996; Levinson and Wilkins 2006: Ch. 1). The sentences that speakers can produce are then analysed with respect to their grammatical and semantic properties, and their relation to the pictorial context of evaluation. We therefore decided to design a task in which participants would evaluate the use of sentences in different contexts, in a manner similar to the Topographic Relation Picture Task.

**Participants**

Participants were undergraduate students (N = 64, age range 21; 0–25; 0 years) who joined the study on a voluntary basis. Participants were asked if the test sentences could be used to describe scenarios (i.e., contexts) describing different spatial configurations. Participants were evenly balanced among genders, had normal or corrected-to-normal eyesight, and had no history of speech impairment. Participants originated from several Chinese provinces, but no participant reported knowledge of dialects or forms of bilingualism. We nevertheless leave open the possibility that geographical, social, or register influences may have affected participants’ answers in the task. Participants were recruited via an advertisement in the faculty message board and had to sign a consent form before participating (see the **Supplementary Materials**). The consent form granted anonymity in the treatment of personal data and the disclosure of the study’s goals after its completion if participants wished to access it.

**Materials**

The test sentences involved the three prepositions zai “at”, dao “to”; and cong “from”, alone and in combination with localisers. These prepositions respectively cover “location”, “goal”, and “source” directional sense types, i.e., the most common directional sub-types across languages (Stolz et al., 2014: Ch. 1). To test the polysemy of these prepositions, we used sentences lacking localisers but including place names or ground NPs referring to unique, salient locations in context (cf. Beijing in 2), from the Introduction). For localisers, we tested each simple localiser in 6) in combination with each preposition. We tested a subset of compound localisers derived from the localisers referring to the horizontal axis (zuo “left” and you “right”), the vertical axis (xia “up” and shang “down”), and the longitudinal axis (qian “front” and hou “back”). We examined whether each of the suffixes (i.e., -bian “face”, -bian “side”, -tou “head”, -bu “part”, and -fang “direction”) would cover unique senses denoting highly specific locations. We also examined whether prefix zhi- would cover senses denoting “distal” locations along these axes (e.g., zhi-shang denoting a relation that can be glossed as “above” vs. “on”).

We organised sentences according to the “location type” to which localisers can refer. These are in turn defined via a combination of semantic dimensions that partition the conceptual domain of space (cf. Cresswell 1978; Levinson 2003: Ch. 1; Levinson and Wilkins 2006: Ch. 1; Zwarts 2017). First, we distinguished between axial and topological localisers. The first group refers includes the aforementioned six localisers plus localisers bei “North”, nan “South”, dong “East”, and xi “West”, to be defined in the next paragraph. The second group includes li “in,” wai “out,” and nei “within”: localisers that can refer to internal/external (i.e., topologically defined) locations. Note that the spatial senses of wai and nei seem rarely used in current Mandarin (Huang et al., 2017: 217). We thus monitored their acceptance in context as being possibly linked to speakers’ infrequent use of these rare senses.

We also identified localisers according to the reference system they capture: intrinsic, relative, and absolute/cardinal (Levinson...
and Wilkins 2006; Palmer 2015; Palmer et al., 2017a). A relative reference system involves a speaker describing a figure’s position from the speaker’s reference point, whereas an intrinsic system involves the ground’s reference point. For instance, if a speaker is behind a car acting as a ground, a ball is in front of the speaker, and the speaker uses a relative reference system, then the ball can be described as being “in front” of the car. If the speaker uses an intrinsic relative system, then the ball can be described as “behind” the car. Via this semantic dimension, we split bei, nan, dong, and xi into the cardinal (axial) subset. We then assumed that the other axial localisers are ambiguous between intrinsic and relative senses. Furthermore, it is known that terms referring to “left” and “right” locations display strong context sensitivity for their disambiguation (cf. Levinson 1996; Levinson and Meira 2003). We thus monitored their acceptance rates in relation to contextual disambiguation.

Overall, we tested 13 × 6 = 78 localisers in combination with three prepositions (i.e., 234 items). We deemed this a sufficient number of sentences to test our hypotheses but also to avoid overloading participants. Sentences were presented in a random order, to avoid cueing effects in answers (Schütze and Sprouse 2013; and references therein). For instance, the pair testing whether qian-mian and qian can be used in the same context was the 20th and 47th test sentences, respectively, in the overall list. We acknowledge that a fully randomised presentation of the sentences would have been the best option, but for practical reasons (i.e., the test being very long), we could only resort to this simpler method. At 64 participants and 234 items, we collected a total of 64 × 234 = 14,976 token sentences, which were then processed for statistical analysis. A file presenting the full list of sentences is found in the Supplementary Materials to this article.

Procedure
Participants received the written task with the full list of sentences, with no time limit for completion. Each sentence was tested against a text describing a fictional scenario that acted as an extra-linguistic context of evaluation. Contexts introduced a short description of a target relation holding between figure and ground. For instance, the acceptability of 1) was tested by describing a context in which a man called Zhangsan was in front of the desk and thus whether 1) (i.e., Zhangsan zuo zai zhuozi qian) would aptly describe this context. Conversely, a sentence such as 2) (i.e., Zhangsan zai Beijing) can also be used in contexts in which Zhangsan is in some other location (e.g., near or North of Beijing). Instead, 3) and 4) (respectively, Zhangsan zai Beijing bei and Zhangsan zai Beijing de bei-bian) can only be used to describe Zhangsan as being in the northern “region” of this city, via bei and bei-bian.

We designed sentences in related subsets: without localisers (e.g., 2)) and with localisers (e.g., 3)–4)). Both sentences could accurately describe a context, but speakers’ answers would determine if the absence of localisers was acceptable and, consequently, if prepositions could be polysemous in context. Our reason for choosing this binary choice (acceptable/ unacceptable) instead of other options, e.g., Likert scales, was as follows. Likert scales can be used to evaluate if participants can accept the grammaticality of sentences, or their accuracy in context (cf. de Clercq and Haegeman, 2018; Murphy 2021).

For grammaticality tests, it is however often useful to establish cut-off points. For instance, de Clercq and Haegeman (2018) present a task involving grammaticality judgements in which sentences were considered grammatical if evaluated as “3” or higher on a 5-point scale. We thus decided to use binary answers but also to invite participants to motivate if sentences were unacceptable due to grammatical or contextual factors (or both). In this manner, participants would explain whether the absence of localisers or the mismatch between sentence content and context would trigger their responses.

Predictions
Our predictions were as follows. We assume that prepositions and localisers display forms of regular polysemy. For instance, zai is polysemous if it covers senses that localisers such as qian and bei can also cover a given sense (cf. again the definition of Apresjan, 1974). If prepositions are polysemous, then speakers would accept sentences without localisers, e.g., Zhangsan zai Beijing (=2)), as referring to a given location under discussion. This can be the case only if the precise status of this location can be retrieved from the context (e.g., Zhangsan is described as being located North of Beijing). If prepositions do not display forms of regular polysemy, then sentences lacking a localiser cannot be used in a context in which a specific location is under discussion. Given the fact that polysemy in prepositions may involve categorial boundaries between prepositions and localisers, we assume that this property may not be absolute. Most but not necessarily all speakers may accept polysemous prepositions in context.

A second, consequent prediction is that if prepositions are polysemous, then localisers can display hyponymy relations with them (e.g., zai and bei). This may be the case because localisers can refer to some of the distinct but related locations that prepositions can refer to. This prediction can be confirmed by evaluating if participants would accept a first sentence without a localiser and a second sentence with a localiser in the same contexts. A third prediction is that simple and compound localisers can also enter hyponymy relations (e.g., bei-bian and bei). This prediction can be tested by also analysing the use of paired simple and compound localisers in the same contexts. With these predictions in mind, we turn to the results.

RESULTS
The goal of this section is to present the results regarding prepositions, simple localisers (The Polysemy of Prepositions: Variation and Simple Localisers), and compound localisers (Compound Localisers). We conclude by outlining the desiderata for an account of their polysemy and hyponymy relations (Interim Summary).

The Polysemy of Prepositions: Variation and Simple Localisers
The results suggest that a certain degree of nuanced intra-speaker variation emerged when testing the polysemy of prepositions. Participants differentiated among “location types” (i.e., axial,
topological, and cardinal types) when evaluating the acceptability of sentences in context. Furthermore, for some localisers, subtle contextual factors further affected acceptance rates. We illustrate this variation via Table 1.

Participants rejecting sentences without localisers usually observed that localisers’ absence appeared grammatical but poorly matching the context for them. Participants accepting these sentences acknowledged that prepositions could be used to refer to the locations under discussion in a context. The presence of matching localisers was however preferred because it explicitly introduced reference to the location under discussion (e.g., qian to refer to a “front” location). Location types played a role, with some subtle type-internal differences. Participants preferred the presence of cardinal locations and their matching localisers (e.g., bei “north”) in a statistically significant manner. Participants accepted the absence of topological li, wai, and nei in context, though their presence led to different results, as we discuss in the next paragraph. A similar pattern held for zuo and you when used with dao and cong. Participants motivated their reticence to accept sentences without these localisers, as the context would leave open whether reference to an intrinsic or relative “left/right” location was under discussion.

TABLE 1 | Descriptive statistics and chi-square test statistics of zai, dao, and cong.

|        | Zai (bei “north”) | Zai (nan “south”) | Zai (dong “east”) | Zai (xi “west”) | Zai (nei “within”) | Zai (li “in”) | Zai (wai “out”) | Zai (qian “front”) | Zai (hou “back”) | Zai (zuo “left”) | You “right” | Shang “on, above” | Qian(p)NULL | Hou(Null) |
|--------|------------------|------------------|------------------|----------------|------------------|----------------|----------------|------------------|----------------|----------------|-------------|-----------------|-------------|----------|
| Mean  | 1.484 ± 0.504    | 1.531 ± 0.503    | 1.531 ± 0.503    | 1.547 ± 0.502  | 1.319 ± 0.467    | 1.219 ± 0.417  | 1.172 ± 0.390  | 1.266 ± 0.445    | 1.328 ± 0.473  | 1.344 ± 0.479  | 1.266 ± 0.445 |
| SD    | 10.360           | 16.298           | 16.298           | 18.574         | 2.860            | 2.012          | 5.003          | 0.360            | 0.241          | 0.583          | 0.360        |
| Asymp. Sig. | 0.001 (3)       | 0.007            | 0.007            | 0.007          | 0.091            | 0.156          | 0.028          | 0.548            | 0.623          | 0.548          | 0.548        |

TABLE 2 | The acceptance rates of sentences including localisers referring to locations, divided per preposition type (zai, dao, and cong).

|        | Zai (bei “north”) | Zai (nan “south”) | Zai (dong “east”) | Zai (xi “west”) | Zai (nei “within”) | Zai (li “in”) | Zai (wai “out”) | Zai (qian “front”) | Zai (hou “back”) | Zai (zuo “left”) | You “right” | Shang “on, above” | Qian(p)NULL | Hou(Null) |
|--------|------------------|------------------|------------------|----------------|------------------|----------------|----------------|------------------|----------------|----------------|-------------|-----------------|-------------|----------|
| Mean  | 1.688 ± 0.467    | 1.656 ± 0.479    | 1.625 ± 0.488    | 1.688 ± 0.467  | 1.406 ± 0.495    | 1.688 ± 0.467  | 1.313 ± 0.467  | 1.719 ± 0.453    | 1.719 ± 0.453  | 1.719 ± 0.453  | 1.484 ± 0.504 |
| SD    | 0.048            | 0.563            | 1.714           | 0.048          | 0.048            | 0.048          | 0.107          | 0.107            | 0.107          | 0.107          | 0.448        |
| Asymp. Sig. | 0.827            | 0.445            | 0.190            | 0.827          | 0.827            | 0.827          | 0.743          | 0.743            | 0.743          | 0.743          | 0.827        |

Note. The table offers the mean and SD values for sentences including bare prepositions (i.e., sentences lacking a localiser). Expectation value was set at 0.7; asymptotic signature values display deviation from the expected outcome (cf. Abu-Bader 2021). We place prepositions on columns and possible locations on rows. We use localisers to capture which location was under discussion in each example. For instance, the cell on the zai column and the qian row shows that participants accepted a sentence including zai but lacking qian in a context in which a “front” location was under discussion, as per predictions (cf. 11).

Descriptive statistics and chi-square test statistics of

|        | Zai (bei “north”) | Zai (nan “south”) | Zai (dong “east”) | Zai (xi “west”) | Zai (nei “within”) | Zai (li “in”) | Zai (wai “out”) | Zai (qian “front”) | Zai (hou “back”) | Zai (zuo “left”) | You “right” | Shang “on, above” | Qian(p)NULL | Hou(Null) |
|--------|------------------|------------------|------------------|----------------|------------------|----------------|----------------|------------------|----------------|----------------|-------------|-----------------|-------------|----------|
| Mean  | 1.688 ± 0.427    | 1.766 ± 0.427    | 1.676 ± 0.427    | 1.766 ± 0.427  | 1.391 ± 0.492    | 1.719 ± 0.453  | 1.688 ± 0.467  | 1.750 ± 0.436    | 1.750 ± 0.436  | 1.750 ± 0.436  | 1.484 ± 0.504 |
| SD    | 1.313            | 1.313            | 1.313            | 1.313          | 29.170           | 0.107          | 0.048          | 0.762            | 0.762          | 0.762          | 0.448        |
| Asymp. Sig. | 0.252            | 0.252            | 0.252            | 0.252          | 0.000            | 0.743          | 0.827          | 0.623            | 0.623          | 0.623          | 0.827        |

Note. Expectation value is as per Table 1. Thus, the first row shows that sentences including bei and zai, bei and dao, and bei and cong in a context introducing a “north” location were unproblematic. We discuss statistically significant cases in the main text.

*0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 19.2.
The results regarding the acceptance of sentences including localisers reveal that semantic dimensions/location types and their role in context were significant. We show the relevant results in Table 2.

These results highlight that four of our localisers were not always accepted in the context provided in the study: wai, nei, zuo, and you. For wai and nei, a factor we mentioned in Materials played a role: their spatial senses seem rare in Modern Mandarin. Participants who accepted sentences including these localisers acknowledged that their spatial use was perhaps a bit surprising but adequate in the proposed context. Participants who did not accept these sentences admitted that they found this use extraneous to their understanding of these localisers. They would generally prefer compound localisers li-mian “in-side” for li and wai-mian “out-side” for wai. Similarly, participants who accepted you and zuo observed that they preferred an “intrinsic” use in context mediated via you-bian and zuo-bian. They interpreted sentences without these localisers, in the same context, with such a use. For these localisers, intra-speaker variation thus involved how participants accessed their item-specific senses, in line with previous analyses (e.g., Huang et al., 2017; Ursini et al. Polysemy and Sense Relations in Mandarin).

To better offer an overview of the general results, we discuss some examples from a qualitative perspective. Participants were asked if 9) and 10) could describe a context in which Zhangsan would be in a given study room. Most but not all participants accepted 9), whereas all participants accepted 10) as accurate in context: it included cardinal localiser bei (M ± SD = 1.484 ± 0.504):

9) Zhangsan zai shufang.
Zhangsan is in the study room.

10) Zhangsan zai shufang bei.
Zhangsan is in the study room.

11) Jundui zai chengbao de damen qian.
Army is in front of the castle’s gate.

12) Jundui zai chengbao de damen qian.
Army is in front of the castle’s gate.

13) Dijun zai Xiaoang cun.
Enemy is at the Xiaoang village

14) Dijun zai Xiaoang cun bei.
Enemy is north of the Xiaoang village.

Most participants did not accept the sentences in 9), 11), and 13) but based their answers on the absence of a context-matching localiser. They found these sentences grammatically deviant, even if they could to an extent describe the context under discussion. Conversely, participants accepting pair-wise examples such as 9)–10), 11)–12), and 13)–14) also accepted that localisers ideally referred to the location under discussion in each context. They accepted that a preposition can refer to one location (e.g., zai) and a localiser can also refer to that location (e.g., qian). Therefore, they accepted that preposition and localiser stand in a hyponym relation (e.g., zai and qian form a hyponymy relation). We can conclude that polysemy begets hyponymy, for participants who accepted the polysemy of prepositions.

A similar picture emerges for dao and cong, thereby confirming the roles of semantic dimensions and context sensitivity in the acceptance of their polysemy. For instance, participants were split when dao “to” described a context in which nan “South” referred to the location under discussion (cf. 15)–16): M ± SD = 1.547 ± 0.502). Axial locations improved rates (for 17), vs. the acceptable 18) including hou: M ± SD = 1.375 ± 0.488). When cong “from” was used to describe Zhangsan as moving out of a room, a majority of participants accepted 19), but almost all accepted 20) (M ± SD = 1.359 ± 0.484). The use of axial localisers was also preferred over their absence in context. However, for zuo and you, variation approached statistical significance. Participants observed that reference to an “intrinsic” location made sentences unproblematic, unlike “relative” cases (cf. 21)–22) with zuo: M ± SD = 1.469 ± 0.503):

15) Dijun dao le Xiaoang cun.
Enemy is at the Xiaoang village.

16) Dijun dao le Xiaoang cun nan.
Enemy is at the Xiaoang village south

17) Jundui dao le chengbao de damen.
Army is at the castle’s gate.

18) Jundui dao le chengbao de damen hou.
Army is behind the castle’s gate.

19) Zhangsan cong shufang zou chulai le.
Zhangsan has come from the study room.

20) Zhangsan cong shufang li zou chulai le.
Zhangsan has come from inside the study room.

21) Jundui cong chengbao de damen chufa le.
Army is at the castle’s gate.

22) Jundui cong chengbao de damen zuo chufa le.
Army is at the castle’s gate.

Overall, we found that most participants interpreted the triplet of prepositions zai, dao, and cong as polysemous, i.e., as potentially covering the senses of localisers in context. Deviation from an ideal case was minor for axial sense types and the localisers that would capture these senses: qian “front”, hou “behind”, xia “down”, and
shang “up”, Note that sentences referring to “right” and “left” locations and only including prepositions dao “to” and cong “from” approached statistical significance (cf. Table 1 Asymp. Sig. < 0.05). Variation depended on items’ semantic properties for topological sense types and their localisers: li “in”, wai “out”, and nei “within”. Instead, cardinal sense types and their localisers (i.e., bei “North”, xi “West”, dong “East”, and nan “South”) involved statistically significant deviations from the expected outcomes (c.f. Table 1 Asymp. Sig. < 0.001, with Asymp. Sig. < 0.05 for zai + bei).

Therefore, intra-speaker variation emerged when the sense ranges of prepositions included these sense types. Nevertheless, most speakers accepted that these prepositions could cover at least some of the senses associated with localisers. Variation ultimately involved which locations would be included in each preposition’s range. Thus, most speakers also indirectly accepted that hyponym relations would hold among these vocabulary items, as per predictions.

**Compound Localisers**

We begin with a brief reminder: simple localisers can combine with the suffixes -mian, -bian, -tou, -bu, and -fang to form compound localisers. In so doing, they can respectively refer to the sides, facades, edges, parts, and directions defined with respect to a given axis, cardinal point, or topological (internal/external) location. The data involving compound localisers thus involve a further dimension of semantic variation. We isolate three significant patterns from the data via examples and discuss the acceptance rates specific to these data.

First, participants generally confirmed that compound localisers would have more restricted senses than their simple counterparts. Participants thus indirectly confirmed that simple and compound localisers would enter restricted hyponym relations. For instance, informants generally accepted that while 23) could be used to describe the figure being in any “posterior” location, 24–25) restricted hou’s sense to a “side” type of location. We approximate hou’s sense via the English preposition “behind,” although there are clear sense differences between hou and this preposition (cf. Tyler and Evans, 2003: Ch. 4). Crucially, these sentences were tested in a context in which an individual called Lisi occupied a location described as the “back side” of a house, as (23)–(25) show:

23) Lisi zai fangzi hou.
Lisi z house h
“Lisi is behind the house.”

24) Lisi zai fangzi de hou-mian.
Lisi z house de H-façade
“Lisi is at the back side of the house.”

25) Lisi zai fangzi de hou-bian.
Lisi z house de H-side
“Lisi is at the back side of the house.”

Overall, hou acts as a hyperonym term to hyponyms hou-mian and hou-bian. The same reasoning can be extended to each localiser and set of corresponding compound localisers.

Second, compound localisers were generally interpreted as monosemous, i.e., as referring to only one location type. For instance, participants did not accept qian-mian and qian-bian in a context in which luggage was in the front of a given car (e.g., its trunk: cf. 26)). In such a context, qian-bu was instead considered appropriate (cf. 27)). In contexts in which one talks about the “edge” or “extremity” of an object, then only the suffix -tou becomes accessible, mostly in combination with li and wai. For instance, li-tou was deemed acceptable to describe some luggage in the trunk of a car as the car’s extremity, but it was considered unacceptable in any other context (cf. 28a–b)). The suffix -fang was generally preferred when a figure was along an axis of a ground and at a non-minimal (or “distal”) distance from the ground (cf. 29)). For most participants, the prefix zhi- also captured a “distance” sense when attached to localisers xia “down” and shang “up” (cf. 30):

26) Xingli zai chezi de qian-mian/qian-bian.
Luggage z car de Q-façade/Q-side
a. “The luggage is in front of the car.”
b. “The luggage is in the front of the car (=in the car’s trunk).”

27) Yinqing zai chezi de qian-bu.
Engine z car de Q-part
a. “The engine is in front of the car.”
b. “The engine is in the front of the car (=in the car’s trunk).”

28) Xingli zai chezi de li-tou.
Luggage z car de Li-edge
a. “The luggage is inside the car.”
b. “The luggage is inside the car’s trunk (=in the car’s edge).”

29) Xingli zai chezi de hou-fang.
Luggage z car de H-axis
a. “The luggage is behind the car.”
b. “The luggage is far behind the car.”

30) Cunzhuang zai shanggu zhi-xia.
Village z valley ZH-X
“The village is below the valley.”

Overall, these data suggest that the semantic dimensions of “distance” and “part type” are also part of localisers’ senses and that the specific combinations of these senses associated with each localiser may render them monosemous. For instance, one can define only one location as being the “front side” of a ground. Thus, the localiser qian-mian can have only one sense, which allows reference only to this location.

Third, for most speakers, axial qian, hou, shang, and xia would display a minimal form of polysemy with respect to this “reference system” sense dimension, but more regularly than for you and zuo. The specific patterns can be illustrated by taking qian as an example. For this pattern, we used the coordination test to investigate the “co-existence” of these senses (cf. again The Polysemy of Mandarin Spatial Categories: Previous Studies). Most participants accepted the use of qian in a context in which multiple children (i.e., figures) could occupy the “intrinsic front” of a first car but the “relative front” of a second car (cf. 31); M ± SD = 0.743 ± 1.686). Compound
localisers *qian-mian* and *qian-bian* would license similar though slightly decreasing responses, and so would *qian-fang* (cf. 32) *M ± SD* = 1.714 ± 1.824. Compound localiser *qian-bu* would instead only license an “intrinsic” sense in this context. Participants understood that the children occupied the front “parts” of each car (cf. 33); *M ± SD* = 0.629 ± 2.545:

31) *Haizi men fenbie zai Fute che he Fengtian che qian.*
   Child PL respectively *z* Ford car and *Toyota car q*
   “The children are in front of the Ford and the Toyota cars.”

32) *Haizi men fenbie zai Fute che he Fengtian che qian-mian/qian-bian/qian-fang.*
   Child PL respectively *z* Ford car and *Toyota car q-façade/q-side/q-axis*
   “The children are in front of the Ford and the Toyota cars.”

33) *Haizi men fenbie zai Fute che he Fengtian che qian-bu.*
   Child PL respectively *z* Ford car and *Toyota car q-part*
   “The children are at the front of the Ford and the Toyota cars.”

Overall, these three qualitative results highlight that simple localisers can also be polysemous, though their polysemy involves more restricted semantic ranges. The “location type” (e.g., “side,” “axis,” and “cardinal”), “reference system” (e.g., “intrinsic,” “relative,” and “absolute”), and “distance” semantic dimensions determine how these senses become increasingly specific. From a quantitative point of view, it seems clear that simple and compound localisers stand in hyponym relations. We thus suggest that some compound localisers are monosemous because they involve unique combinations of these dimensions and values. If *qian* can refer to any location type along a “front” axis, then *qian-mian* can only refer to a “front side” location type. Localisers thus seem to spell out the distinct semantic dimensions defining the semantic domain of Mandarin spatial categories.

**Interim Summary**

Let us take stock. Our results show that the polysemy of Mandarin prepositions (here, *zai*, *dao*, and *cong*) is intertwined with intra-speaker variation and that this variation hinges on the sense type used in context. Most but not all informants accepted prepositions occurring without localisers when carrying “axial” and “topological” senses in context, but they were split on “cardinal” senses and, to a lesser extent, the “relative” pair *zuo and you*. Furthermore, informants confirmed that simple localisers could carry senses restricted to these sense dimensions, though with some *provisos* (e.g., the *nei* and *wai data*). They also confirmed that compound localisers would further be restricted in the “part location type” that their senses cover. These facts entail that compound localisers may be monosemous and stand in hyponym relations with simple localisers, which display restricted forms of polysemy. These facts also seem to entail that hyponymy relations seem to hold among prepositions and localisers, though intra-speaker variation and context sensitivity are again key factors.

We can therefore conclude that we have reached our first goal: offering an overview of the regular spatial polysemy and hyponym relations of Mandarin spatial categories. We also have reached our second goal: show that a form of nuanced intra-speaker variation exists, based on the sense dimensions defining this polysemy. Our third goal becomes an account of these data that must capture the following three facts in a systematic manner. First, prepositions can act as hyponym-like items to localisers, given their broader polysemy. Second, the hyponym-like relations between simple and compound localisers suggest that one may define a spatial taxonomy of senses. Third, the apparent monosemy that affixes trigger must also receive an account (i.e., -mian, -bian, -fang, -bu, -tou, and prefix *zhi*). To this account, we turn.

**A SEMANTIC ACCOUNT OF THE DATA**

The goal of this section is to introduce our account of the data, based on the semantic maps approach (Basic Assumptions and a Semantic Map for Zai). We offer a model of the polysemy and sense relations in prepositions (Prepositions and Their Schemas: *Dao and Cong*) and localisers (Localisers and Hyponym Relations), paving the way for our general discussion.

**Basic Assumptions and a Semantic Map for Zai**

Within typology, a method to account semantic variation is that of *semantic maps* (Croft, 2001; Haspelmath 2003; Cysouw 2010; Cysouw et al., 2010). Semantic maps involve two components: conceptual spaces (“models” in Croft 2001) and lexical matrices. Lexical matrices present senses/functions attested in a language and then assigned to each item in a category. Conceptual spaces represent cognitive, possibly non-linguistic concepts that languages can express (e.g., colour; Regier, et al., 2013). They are generally represented as either connected graphs (Haspelmath 2003) or Euclidean spaces (Croft and Poole 2008). Cognitive Linguistics proposes similar but not identical models. Most proposals use *Idealized Cognitive Models*, graph-like maps representing sense networks of single vocabulary items (e.g., Lakoff, 1987; Lakoff and Turner 1989; Gibbs 1994; Tyler and Evans, 2003; Glynn 2012, 2014; Evans, 2015). A prototypical sense (e.g., “enclosure”) can be refined via the addition of further senses (e.g., “enclosure and support”). Networks, in turn, form radial categories: specific senses are derived from the prototypical sense via the addition or omission of semantic features.

The semantic maps model eschews the existence of prototypical senses; nevertheless, they represent polysemy via network senses-like graphs. Cognitive approaches do not specify the nature of relations between prototypical sense and other senses: senses are inherently distinct. Thus, each approach has its own *pros and cons*. We propose to overcome this theoretical *impass* by using a combination of the two perspectives along the following points.

First, we base our model on *Image Schemas*, structured representations of perceptual information associated with senses and their relations (e.g., Johnson 1987; Lakoff 1987; Langacker 1987, 1991, 2008; Tyler and Evans, 2003; Ch. 2; Hampe 2005; Zwitserlood 2005; Kang 2012). Image schemas (or schemata, in some works) tend to represent such information in abstract terms. The “inclusion” schema, for instance, simply
represents a figure as being within the location occupied by a
ground, with both referents possibly idealised to points in space.
Our maps follow a similar philosophy but take a more fine-
grained, paradigmatic approach to the representation of
locations, as we explain in the remainder of this section.
Second, we determine the locations and axes that are part of
these maps by using the sense dimensions that we have
individuated in the Results section. Axial localisers refer to
different types of locations along a given axis. For instance,
qian refers to the possible locations along the “front” semi-axis
and hou to the “back” semi-axis (cf. Figure 1). Similar reasoning
extends to pairs shang “up” and xia “down,” and zuo “left” and
you “right.” Compound localisers can partition this complex
location into more specific locations: for instance, qian-mian
refers to the “front side” location of a ground and qian-bu the
(intrinsic) “front part.” Topological localisers refer to internal
(e.g., li “in” and nei “within”) or external (e.g., wai “out”) locations;
cardinal localisers (e.g., bei “north”) refer locations
defined via the cardinal system. Compound localisers involving
suffix -fang and prefix zhi- refer to locations at a “distal” distance
from the ground. Other compound localisers refer to locations
that may be “proximal” to the ground, whether they be “internal”
(e.g., -tou) or external (e.g., -bian).
Third, we use the following visual conventions to represent
these locations. We use circles to represent undirected locations
and directed and continuous lines (“vectors”) to represent axes/
projections, i.e., directed locations. We label sets of connected
locations as “regions” and sets of connected projections as “axes”.
We then use sequences of segmented, directed lines (“paths”) to
represent directions. Hence, paths represent motion “to” and
“from” the ground; vectors represent axes/directions defined via
specific locations (e.g., Jackendoff 1983, 1990; Lakoff and Núñez,
2000; Ch. 2; Zwarts and Winter 2000: 209; Zwarts 2005; Langacker
2008: 340–380; Kang 2012; a. o.). Our maps thus represent regions,
locations, paths, and axes as distinct spatial referents that can
nevertheless be defined with respect to the ground.

FIGURE 1 | The semantic map for zai and its range of possible locations. The map represents a ground as an idealised cube, abstracting away from the role of
shape in determining the nature of the locations to which prepositions and localisers refer. Zai’s potential polysemy domain is represented as a cylinder-shaped (“halo”) region encompassing all the regions/locations that localisers refer to. For instance, the “front” location to which qian-mian refers is part of zai’s halo. Locations also carry
different shades to represent the “strength” of hyponym relations. This figure represents this fact by having the four cardinal locations be in dark grey and other
locations in light grey. A consequence of building semantic maps in this manner is that distinct categories may stand in hyponym-like relations. As our map shows,
prepositions may refer to “general” regions, for speakers that accept their polysemy: localisers thus refer to more “specific” regions within these general regions.
Categorial distinctions play a role at a grammatical level of organisation, but not at a conceptual level.
Fourth, we represent a ground as a three-dimensional object and the centre of a semantic map. From this centre, we define a set of spatial referents via the semantic dimensions that localisers can cover. We can represent the polysemy of simple localisers via their ability to refer to regions or axes, i.e., sets of connected locations or projections that monosemous compound localisers can independently individuate. We therefore represent hyponymy relations via mereo-topological (i.e., spatial “part-of”) relations. For instance, the specific “front part” region that qian-bu refers to is part of the “front axis” that qian refers to. We thus represent the conceptual relation between polysemy and hyponymy by showing that the semantic range of one vocabulary item can be part of the semantic range of another vocabulary item.

Fifth, we represent intra-speaker variation with respect to their acceptance of prepositions’ polysemy via a shading code. Circles with a light grey shade represent locations for which most speakers accepted sentences with and without localisers (e.g., the “front” location). Circles with a dark grey shade represent locations for which acceptance rates were statistically significant (e.g., the “North”) location. For these locations, participants rejected sentences without localisers more than our original predictions, whence the darker shade. We illustrate this point via the proposed map for zai.

The map in Figure 1 suggests that zai may refer to a “halo” region that can include the regions and axes that localisers can refer to (i.e., the halo includes all the circles; cf. Asher and Sablayrolles 1995). This is also a visual representation of the cumulative hyponymy relations holding between zai and localisers. Zai can potentially act as a hyperonym to localisers, since its halo-like region includes other regions and locations as its distinctive parts. The shading principle shows that not all participants may consider zai and a localiser potentially referring to the same location/region. For some speakers, such locations must be excluded from zai’s halo, which can thus have “holes” in its semantic domain. The four locations expressed via the cardinal localisers dong, xi, nan, and bei (respectively, “east”, “west”, “south”, and “north”) represent such holes in zai’s map. To illustrate these differences in acceptance patterns, we present a map in which we differentiate locations according to their shading code in Figure 2.

The maps in Figure 2 may be read from left to right as presenting snapshots or comic-like panels that show how zai’s halo may extend in covering different location types, but may also “weaken” as a result. Participants accepted that zai could refer to locations more directly connected to the ground and its parts, but the extension of zai’s semantic halo to cardinal locations was considered weaker. In this regard, the map in Figure 1 can be conceived as integrating the two maps into Figure 2 into a more inclusive since Figure 1 also includes the four other tested locations (i.e., nei “within”, wai “out”, zuo “left”, and you “right”). Once we have a clear definition of the model, we can explain how data are represented. We thus introduce Figures 3, 4 in the next section to explain the representation of dao and cong’s senses.

Prepositions and Their Schemas: Dao and Cong

Let us address dao and cong and their potential polysemy. Recall that these prepositions involve a notion of “directedness”: “to” the ground for dao and “from” the ground for cong. As our data show, most participants accepted the possibility that these prepositions can be polysemous in a manner similar to zai. A minimal sense difference with zai is that dao and cong would refer to these locations as “goals” and “sources” of moving grounds,
respectively. We thus adopt the same shading code that we use for zai. We offer the corresponding maps in Figures 3, 4.

Overall, our maps show that these prepositions are potentially polysemous: all participants accepted that they could refer to some locations that localisers would also refer to. Participants would differ on the polysemy range assigned to each preposition, as the "cardinal type" data show. In the proposed maps, this fact is captured via the shading code. The fewer speakers would accept, e.g., zai to refer to a location (e.g., "north"), the darker such location is shaded, hence resembling a "hole" in the map (cf. again Figures 1–4 and the shades associated with cardinal localisers). Halos thus represent the potential regions that prepositions can refer to, in sentences lacking a localiser. However, intra-speaker variation emerges when one looks at what "location types" are part of this polysemy. We can thus conclude that the quantitative results discussed in Results regarding the "strength" of the polysemy of these prepositions also find a visual representation in the maps.

Localisers and Hyponym Relations

We turn our attention to localisers and their restricted forms of polysemy. For this purpose, we introduce the map that we associate to qian and its hyponym localisers in Figure 5.

As the figure shows, a localiser can refer to a set of locations defined along a given axis. The "location types" involved in this form of polysemy can be defined via the senses of the suffixes attaching to each localiser. This type of analysis may be extended to the other localisers (e.g., hou "back", xia "down", and shang "up") to define localiser-specific maps that can be combined into the general maps offered in Figures 1–4. The restricted regions of space that these localisers refer to can also be conceptualised as paths (cf. again Figures 3, 4). Thus, the path reaching the "front side" location and the path leaving this location respectively represent this location as a "goal" and a "source" that a figure reaches or leaves. The hyponym relations between pairs of simple and compound localisers that emerge from our data also receive a visual representation. For instance, the "front side" location that qian-mian refers to becomes part of the larger region that qian refers to, i.e., the set of circles also marked via the qian label. The white shading represents the fact that all participants accepted these relations in context, due to the restricted polysemy of qian.

Since the map in Figure 5 does not allow us to discuss the semantic contribution of prefix zhi-, we offer one map dedicated to this task in Figure 6.

Compound localisers can possibly refer to only one of these regions and can thus be monosemous. Our maps show that, for instance, -bu individuates the "parts" of an object as a cluster of not necessarily contiguous but nevertheless connected locations (cf. qian-bu in Figure 5). When this suffix combines with a localiser, the locations that both elements can refer to become the locations that a compound localiser can refer to. For instance, if li refers to an
in (ner) region and -bu “part” a region (type), then li-bu refers to an “in (ner) part” region. Instead, the suffix -tou refers to a single region at a certain distance and axis/direction from the ground (e.g., qian-tou denoting a “front edge” location). The maps also show that affixes seem to refer to location types, i.e., locations individuated via given properties. Thus, zhi- localisers refer to locations that are at a “distal” distance from the ground, as the zhi-shang and zhi-xia locations show (cf. again Figures 1, 3, 4).

Overall, we can represent the fact that these affixes partition a spatial semantic domain involving the “distance”, “reference system”, and “location type” sense dimensions. Via -bu, compound localisers only refer to “parts”. Via -mian and -bian, they only refer to external “sides.” Via -tou, they only refer to “edges”; via -fang but also via zhi-, they only refer to “distal” locations, and -fang also selects “axes.” Cardinal localisers such as bei “north” capture these distinctions but involve an “absolute” reference system. The triplet of topological localisers li, wai, and nei instead defines regions’ clusters that can be conceived as either internal or external with respect to figure’s position to the ground but that lack other senses.

We can therefore conclude that our maps can capture the regular spatial polysemy and hyponymy patterns attested in Mandarin localisers. In so doing, they capture the hyponymy relations that emerge among these items in a systematic manner. Our maps can also capture the nuanced forms of intra-speaker variation associated with the potential regular polysemy of spatial prepositions via a shading code, and the potential hyponymy relations with localisers. Our maps thus represent that polysemy seems sensitive to categorial distinctions (e.g., prepositions vs. localisers), to semantic distinctions (e.g., “axial” and “part type” location types), and to the role of context. We have now reached our third goal: a formal account of the data. We can move to the general discussion.

**GENERAL DISCUSSION**

We believe that six key results emerge from our account that are worth discussing in detail.

First, our maps offer an account of the potential regular polysemy of Mandarin spatial categories. We have shown that Mandarin prepositions zai, dao, and cong can be polysemous for participants who accepted their use without localisers in context. Such uses seem to depend on the “location type” at stake and may even involve the item-specific semantic properties of individual items (e.g., nei “within” and you “right”). Localisers presented a more transparent picture: simple localisers (e.g., qian) cover sense types that compound localisers cover on an even more specific basis (e.g., qian-mian and qian-bian). Therefore, these data show that regular polysemy seems a paradigmatic property in localisers and a property subject to intra-speaker variation for prepositions (cf. Huang et al., 2017). Though nuanced, this picture however sheds new light on regular polysemy in these categories. Most previous

![Figure 4](image-url)
works only investigate prepositions and localisers’ logical polysemy (e.g., spatial vs. temporal senses; Wu and Muchinei, 2018).

Second, our maps capture the fact that informants can accept the restricted polysemy forms of localisers and the hyponymy relations emerging from these forms of polysemy. Crucially, our study makes explicit the range of senses that localisers can cover. Thus, we can say that simple localiser qian covers different location type senses because it can be used in the same contexts of compound localisers (e.g., qian-mian, qian-bian, qian-fang, and qian-bu). Similar reasoning extends to other localisers and their potential affixation via -tou (e.g., li-tou) and zhi- (e.g., zhi-xia). The first and second results therefore support the conclusion that polysemy acts as an inherently multi-dimensional property. What counts as a grammatical/lexical property for some speakers (e.g., zai covering cardinal senses) may become a pragmatic inference for other speakers (cf. Cruse 2004; Murphy 2010; Glynn 2012, 2014, 2016; Carston 2020).

Third, our maps capture the semantic dimensions that seem to partition the semantic domain of space. Simple localisers seem to select senses based on “topological”, “axial”, and “reference system” dimensions (cf. Jackendoff 1983, 1990; Tai 1993; Tai, 2005). Compound affixes can select senses restricted to the dimensions of “distance” (cf. zhi- forms) and “part type” (e.g., -bu forms). This result is consistent with works on the lexical typology of spatial prepositions (e.g., Sinha and Kuteva 1995; Zwarts and Winter 2000; Levinson and Wilkins 2006; Aurnague and Vieu 2015). Thus, our study displays a strong degree of consistency with previous models in the literature. It however adds a general “location type” dimension via the study of compound localisers, as part of a general model of this domain.

Fourth, our study is also consistent with Levinson and Meira’s (2003) conceptual hierarchy, although in a subtle manner. Two aspects offer proof of this theoretical consistency. First, our maps suggest that senses related to “cardinal” (e.g., bei and its sense) and “relative” (e.g., zuo and its sense) dimensions represent a semantic boundary among speakers (cf. also Palmer et al., 2017b). Second, our maps suggest that prepositions and localisers’ grammatical division of labour stem from this conceptual tension. Therefore, hyponymy relations among prepositions and localisers can emerge when localisers refer to regions that are “part of” the regions that “general” zai, dao, and cong cover. This result suggests that Mandarin prepositions and localisers partition the semantic domain of space in hierarchical manners that are reflected at a grammatical level. These partitions, in turn,
reflect cross-linguistic semantic dimensions of variation that, crucially, are not explored in Levinson and Meira’s (2003) work. 

Fifth, via our maps, we offer an approach to polysemy that is mostly semantic but with a pragmatic component. Again, the fact that participants accepted sentences including prepositions without localisers offers evidence confirming hyponymy relations (e.g., zai and hou). This evidence also suggests that multiple senses must be part of items’ representations for these relations to be accessible. However, one can model these relations once their use in context is analysed. Hence, our view appears symmetrical to but perhaps compatible with pragmatically oriented views of polysemy (Falkum 2011; Falkum and Vicente 2015; Carston 2020). Our view places a greater emphasis on the role of grammar and lexicon in polysemy.

Sixth, the perspective that the maps bring about also attempts to connect two parallel but compatible approaches to the modelling of sense and sense relations. The first involves lexical typology and semantic maps (e.g., Cysouw et al., 2010), and the second involves Cognitive Linguistics schemas (e.g., Tyler and Evans 2003; Langacker 2008). Our proposal models spatial senses in Mandarin prepositions and localisers and their polysemy by representing how they refer to locations defined with respect to a ground. In our account, semantic maps and cognitive models become integrated conceptual tools capturing how speakers use spatial categories and their relations in context (Glynn 2012, 2014; for a similar point). Therefore, they define the space of Mandarin spatial categories in a systematic and yet flexible manner. With this point in mind, we can turn to the conclusions.

CONCLUSION

The first goal of this paper has been to offer empirical evidence of the spatial polysemy and hyponymy relations in Mandarin spatial categories. We have shown that Mandarin prepositions (e.g., zai) and simple and compound localisers (e.g., respectively, qian “front” and qian-mian “front-side”) can cover increasingly specific sets of spatial senses, thus displaying decreasing forms of polysemy. These results support the view that these categories operate a distribution of labour on how they capture the spatial relations between figure and ground, and how they cluster spatial senses into cohesive subdomains. The second goal has been to show that these relations can involve nuanced forms of intra-speaker variation, which in turn can inform an account of these data. The third goal has been to offer a formal account based on semantic maps that can also capture the attested intra-speaker variation. The account shows that a visual rendition of these patterns can be offered that models sense types and sense relations as spatial relations among location types. The paper has reached each goal by offering a novel extension of the semantics maps model based on the collected data. The suggested generalisations can thus shed light on how the semantic domain of space is conceptualised in Mandarin and how sense properties such as polysemy emerge from this organisation. Let us remind the reader, however, that our work has focused on three prepositions (zai, dao, and cong) and 13 localisers (e.g., qian, li, and bei: cf. again 6)), among the dozens of vocabulary items that belong to each category. We conjecture that our account can be extended to other prepositions and localisers. However, whether this type of analysis can be extended to all (spatial) prepositions and localisers in Mandarin is a question that we must leave for future work.

A final observation is that our account opens at least three interesting theoretical questions. The first question is whether and how the account is consistent with analyses of logical polysemy in spatial categories, i.e., analyses investigating temporal and metaphorical senses (e.g., Tyler and Evans 2003; Kang 2012). After all, we only have addressed spatial senses. A second complementary question is whether and how the account can also offer insights that can be “translated” into formally oriented accounts of spatial categories. This appears a possibility if one uses the logic of semantic maps to develop such formalisms (cf. Zwarts and Winter 2000; Zwarts 2005, 2017). The third question is whether and how the account can inform syntactic analyses of Mandarin spatial categories (e.g., Chappell and Peyraube 2008; Djamouri et al., 2013; Wu 2015). We believe that these questions can be answered in the positive. However, we must leave such tasks for future research.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the General Ethics Committee, Sun Yat-Sen University. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

F-AU designed the study, wrote the manuscript, and performed the figures’ design. QR designed the study, collated the literature review, and performed the data analysis. YZ ran the experimental portion of the study and prepared the figures and the reference list.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2021.724143/full#supplementary-material
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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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