Wh-indefinites in Mandarin: The case of *shenme* (什么)

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written by

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Abstract

This thesis aims to investigate the semantics of *wh*-indefinites in Mandarin by focusing on a particular Mandarin *wh*-indefinite *shenme* (什么). *Wh*-indefinites have both indefinite and *wh*-interrogative uses. In its indefinite use, *shenme* behaves like an epistemic indefinite triggering an obligatory ignorance inference when unembedded. Additionally, *shenme* displays a form distinction with its two forms – bare and non-bare *shenme* – having slightly different distributions with respect to the uses that epistemic indefinites may possibly license. Using the team semantics framework, I propose that *shenme* is a strict existential with the conditions of variation and maximality.

By these assumptions, I manage to account for the distribution and meaning of *shenme* in its epistemic indefinite use, in particular explaining the different behaviors of bare and non-bare *shenme* under negation. To arrive at a uniform account of the dual use of *shenme* as either an epistemic indefinite or an interrogative word, I develop an account of questions in the team semantics framework. The outcome reveals that the licensing of constituent questions also depends on the maximality condition of *shenme*.

Contents

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Chapter 1

Introduction

Wh-words such as *shenme* 'what' (什么), *shui* 'who' (谁), *nali* 'where' (哪里) in Mandarin Chinese can have a non-interrogative indefinite reading in addition to its interrogative use (Y.-h. A. Li 1992; J.-W. Lin 1998), and I will henceforth refer to them as *wh*-indefinites. Mandarin *wh*-indefinites have long been analyzed as Negative Polarity Items (henceforth NPIs) (L. Cheng 1991; Huang 1982; Y.-h. A. Li 1992; J.-W. Lin 1998; Xie 2007), which can be found in typical NPI-licensing downward entailing environments including negation (2), polar questions (3), and antecedent of conditionals (4), but are to some extent problematic with positive episodic contexts (1). In addition, *shenme* can also appear in some non-downward entailing environments, for example, epistemic and deontic contexts with modals (5), with non-factive predicates (6), and with future-related predicates (7).

(1) *Wo xihuan *shenme* ren.
I like what person
'I like someone.' (Positive episodic contexts)

(2) Wo mei mai *shenme* dongxi.
I NEG buy what thing
'I didn't buy anything.' (Negation)

(3) Ta you tigong ni *shenme* hao de yijian ma?
he have provide you what good MOD opinion PART
'Has he provided you with some good opinions?' (Polar questions)

(4) Ruguo ni you *shenme* haochi de dongxi ...
if you have what tasty MOD thing
'If you have something good to eat ...' (Antecedent of conditionals)

(5) Ta yiding/dagai shi bei *shenme* shi gei dange-le.
he must/probably be by what thing by delay-PRF
'S/he must/might have been delayed by something.' (Modals)

(6) Zhangsan yiwei/renwei wo mai-le *shenme*.
Zhangsan believe/think I buy-PRF what
'Zhangsan believes/thinks that I bought something.' (Non-factive predicates)

(7) Wo mingtian hui qu mai *shenme* dongxi song ta de.
I tomorrow will go buy what thing give him MOD
'I will go to buy something for him.' (Future)

To account for the fact that Mandarin *wh*-indefinites can be licensed by both downward entailing and non-downward entailing environments but not the positive episodic contexts, J.-W. Lin (1998) analyzes *wh*-indefinites as *existential polarity items* licensed by the Non-Entailment-of-Existence Condition (henceforth NEEC). Roughly, NEEC suggests that a Mandarin *wh*-indefinite cannot take scope over its licensor, and none of the aforementioned sentences (2-7) entails the existence of *shenme*'s referent. In a similar way, Lin et al. (2014), Jing Lin and Giannakidou (2015), and Xie (2007) treat *shenme* to be licensed by non-veridical[1] environments, namely, $F\exists x\phi \not\models \exists x\phi$ where F is a propositional operator.

(8) Non-Entailment-of-Existence Condition on *wh*-indefinites
The use of a *wh*-indefinite is felicitous iff the proposition in which the *wh*-indefinite appears does not entail the existence of a referent satisfying the description of the *wh*-indefinite.

However only recently, Z. Chen (2017, 2018, 2021) and Liu and Yu'an Yang (2021) identified the use of Mandarin *wh*-indefinites in positive episodic contexts to suggest the speaker's ignorance. For example, *shenme* in combination with the numeral classifier *yi ge* 'one CL' in (9) refers to a specific North Korean company with probably its name unknown to the speaker. In (10), *shenme* is also used as an indication of the speaker's ignorance about the identity of the person/people[2]. Both (9) and (10) involve veridical environments and require the referent of *shenme* to exist. Such observations however pose a big challenge for NEEC by J.-W. Lin (1998), and the non-veridicality generalization by Lin et al. (2014), Jing Lin and Giannakidou (2015), and Xie (2007).

(9) Ta xianzai zai yi ge, nei ge, chaoxian de yi ge *shenme* gongsi limian
she now at one CL that CL North.Korean MOD one CL what company inside
'She's working in a, um, some North Korean company (some company or other, I don't remember).' (Liu and Yu'an Yang 2021)

(10) Ta cengjing zaodao guo *shenme* ren weixie, bu xu ta shuochu ta zhidao de qingkuang
she ever suffer EXP what person threat not allow she say she know MOD situation
'She was threatened by someone before, who forbade her from telling what she knew (and I don't know who threatened her though).' (Z. Chen 2021)

After identifying the distribution of *shenme* also in positive episodic contexts, Z. Chen (2017, 2021) and Liu and Yu'an Yang (2021) analyze Mandarin *wh*-indefinites to be epistemic indefinites (henceforth EIs) having an ignorance inference, as in Aloni and Port (2010, 2015), Alonso-Ovalle and Menéndez-Benito (2010, 2015), and Kratzer and Shimoyama (2002). From this perspective, *shenme* is similar to German *irgendein* in that both trigger an ignorance effect in specific uses (9-10) and under epistemic modals (5), having an NPI-like narrow scope existential meaning in negative contexts (2), and furthermore exhibit a free choice effect under deontic modals

[1]Non-veridicality is defined in terms of truth: a propositional operator F is veridical iff Fp entails p; otherwise F is non-veridical (Giannakidou 1998, 2002).

[2]Note that (10) is ambiguous, as Mandarin does not have a marker for singularity and plurality of nouns. I will come back to Mandarin nouns in the next section.

(11)[3][4]. The infelicity of (1) is explained by the contradiction between the conventionalized ignorance inference of *shenme* and the naturally assumed context where *I* should know the person that *I* like.

(11) Zhe jian shi, wo kan ni yi ge ren ban bu liao. Yinggai zhao ge *shenme* ren
this CL matter I think you one CL man do not PART should find CL what man
lai bang ni
come help you
'As for this matter, I think you are not able to do it alone. I/You should find somebody to help you (and anybody will work).' Adapted from (J.-W. Lin 1998)

While Z. Chen (2017, 2021) and Liu and Yu'an Yang (2021) mainly focus on the behaviors of *shenme* alone, there are actually two forms of *shenme* worth discussing – *shenme* in its bare form (henceforth bare *shenme*) and *shenme* with a numeral classifier (henceforth non-bare *shenme*) – with the two having slightly different distributions. For example, bare *shenme* can be licensed by negation to have an NPI-like narrow scope existential meaning (12-a), whereas the use of non-bare *shenme* in such a context seems odd (12-b). Even for Mandarin native speakers who accept (12-b), it can only be interpreted to convey the speaker's ignorance of which three specific books that Zhangsan did not buy.[5] Specifically, the fact that *shenme* lacks an NPI-like meaning in (12-b) such as 'Zhangsan didn't buy any three books' requires a finer distinction between bare *shenme* and non-bare *shenme* in addition to the numeral interference, which, to the best of my knowledge, has not been adequately addressed by works on Mandarin *wh*-indefinites.

(12) a. Zhangsan mei mai shenme shu.
Zhangsan NEG buy what book
'Zhangsan didn't buy any book.'
b. ?Zhangsan mei mai san ben shenme shu.
Zhangsan NEG buy three CL what book
'Zhangsan didn't buy any three books.'
'Zhangsan didn't buy three specific books (and I don't know which three).'

Another less investigated puzzle about Mandarin *wh*-indefinites is their ambiguity to also license constituent questions as question words in addition to their EI use in declaratives. For example, as there is neither syntactical nor morphological distinction between interrogatives and declaratives generally in Mandarin[6], (13-a) is a declarative on Zhangsan's buying of books with a conventionalized ignorance inference from the EI *shenme*, whereas its string identical counterpart (13-b) is an interrogative asking for the books that Zhangsan bought. While many *wh*-indefinites in other languages are also found to vary between EIs and question words (Hengeveld et al. 2022), it would be preferable to derive a uniform account for both uses in the case of Mandarin.

[3]The example sentence is from J.-W. Lin (1998) where he takes the deontic modal *yinggai* 'should' as a future-related predicate and does not mention the use of *shenme* to have the meaning that "anybody will work". However, the interpretation of *shenme ren* 'what person' in the sentence from me and other Mandarin native speakers naturally amounts to the free choice reading. For a detailed analysis of *shenme* inducing free choice effects under deontic modals, see section 1.2.4 of this chapter.

[4]In the thesis, I consider only numeral classifiers, and take *zhao ge shenme ren* 'find CL what person' in (11) as a short form for *zhao yi ge shenme ren* 'find one CL what person'.

[5]Z. Chen (2021) briefly mentions (12-b) and treats it to be acceptable with the meaning 'Zhangsan didn't buy three books of a certain kind (and I don't know what kind it is).' However, most of the Mandarin native speakers that I have consulted judge (12-b) to be ungrammatical. Even despite the varied judgement on (12-b)'s grammaticality, it is clear that non-bare *shenme* cannot license an NPI-like meaning the same as bare *shenme*.

[6]However, there are constructions being specific to only interrogatives in Mandarin. For example, the force marker *ma* at the end of a sentence would mark it to be taken as a polar interrogative.

(13) a. Zhangsan mai-le shenme shu.
Zhangsan buy-PRF what book
'Zhangsan bought a book / books (and I don't know which book(s)).'
b. Zhangsan mai-le shenme shu?
Zhangsan buy-PRF what book
'What book(s) did Zhangsan buy?'

This thesis is centered on the Mandarin *wh*-indefinite *shenme* and specifically its interaction with numeral classifiers. Following Aloni and Port (2010, 2015), I identify *shenme* as an EI similar to German *irgendein*, and analyze it as an existential triggering a variation atom together with a maximality requirement in an extension of the framework by Aloni and Degano (2022, 2023) using tools from team logics and dependence logic. In combination with a speech act treatment of assertions and questions, this analysis will yield a uniform account of indefinite and question uses of *shenme* both in its bare and non-bare form.

The thesis is structured as follows. The rest of Chapter 1 briefly introduces Mandarin nouns and classifiers, and sets up the ground for both bare and non-bare *shenme* by showing their distribution with respect to the four functions of EIs as identified by Aloni and Port (2010, 2015), and additionally two other uses that I also intend to account for in the thesis. Chapter 2 reviews three representative approaches to the puzzle of *shenme* and EIs in general, namely, the alternative based approach (Alonso-Ovalle and Menéndez-Benito 2010; Kratzer and Shimoyama 2002), the exhaustification based approach (Chierchia 2006, 2013; Chierchia and Liao 2015; Fox 2007; Law 2019), and the conceptual cover approach (Aloni and Port 2010, 2015). In Chapter 3, I propose to treat *shenme* as an existential triggering a variation atom together with a maximality requirement in the team semantics framework by Aloni and Degano (2022, 2023) extended with an account of plurality, and in Chapter 4, derive its application to both bare and non-bare *shenme* in terms of their distribution. Chapter 5 is devoted to *shenme*'s licensing of constituent questions, with the aim of deriving a uniform account for *shenme* as an EI in declaratives and as a question word in interrogatives. Chapter 6 concludes with remaining puzzles and some ideas for future research.

1.1 Mandarin as a classifier language

In contrast to most Indo-European languages, Mandarin is considered as a classifier language where numerals obligatorily require the occurrence of classifiers when modifying nouns. In addition, classifiers are selected according to some conceptual features of the nouns being modified. For example, *ben* is usually used with nouns for books, periodicals, and files, and *zhi* with nouns for animals.[7]

(14) a. yi *(ben) shu
one CL book
'one book'
b. liang *(zhi) gou
two CL dog
'two dogs'
c. *yi zhi shu
one CL book
'one book'

[7] I will only focus on Mandarin individual classifiers throughout the thesis. For a feature-based four-way classification of Mandarin classifiers, see Appendix A.

d. *liang ben gou
two CL dog
'two dogs'

X. Li (2011) points out that Mandarin is also a number-less and article-less language, as it lacks number morphology to mark the singularity and plurality of nouns (Rullmann and You 2006), and has neither definite nor indefinite articles in addition to demonstratives (L. L.-S. Cheng and Sybesma 1999). As exemplified by (15), both 'dog' (15-a) and 'dogs' (15-b) appear as *gou* in Mandarin, and the form remains the same when modified by the plural quantifier *xuduo* 'many' (15-c)[8].

(15) a. yi zhi gou
one CL dog
'one dog'
b. wu zhi gou
five CL dog
'five dogs'
c. xuduo (zhi) gou
many CL dog
'many dogs'

Due to Mandarin's being number-less and article-less, the bare noun *shu* in (16) can be interpreted in at least four ways: singular indefinite 'a book', plural indefinite 'books', singular definite 'the book', and plural definite 'the books'.

(16) Wo mai-le shu.
I buy-PRF book
a. 'I bought a book.'
b. 'I bought books.'
c. 'I bought the book.'
d. 'I bought the books.'

While bare nouns in Mandarin are generally ambiguous in terms of number and (in)definiteness, nouns with numeral classifiers (henceforth non-bare nouns), for example, *liang ben shu* 'two books' (17), are always indefinite[9] with their number in accordance with the numeral that they combine with (L. L.-S. Cheng and Sybesma 1999).

(17) Wo mai-le liang ben shu.
I buy-PRF two CL book
a. 'I bought two books.'
b. #'I bought the two books.'

Note that both bare and non-bare nouns in Mandarin are compatible with indefinite readings, allowing for them to be combined with *shenme*, which I take as an EI. In the next section, I will move on to EIs, and present how numeral classifiers interact with the Mandarin EI *shenme* to affect its distribution with respect to the uses.

[8] Note that the classifier *zhi* following *xuduo* 'many' is optional. Such optionality of classifiers can also be found within plural quantifiers such as *henduo* 'a lot of' and *haoduo* 'many' (Y.-H. Chen 2023; Hsieh 2008; Tang et al. 2007).

[9] As for why the ambiguity between definiteness and indefiniteness is held by only bare nouns rather than non-bare nouns in Mandarin, see L. L.-S. Cheng and Sybesma (1999).

1.2 Epistemic indefinite

Aloni and Port (2010, 2015) characterize EIs as indefinites having a conventionalized ignorance inference. They also identify four functions of EIs: specific unknown (**SU**) and epistemic unknown (**epiU**) when used specifically or under epistemic modals; negative polarity (**NPI**) under downward entailing operators, if licensed; and deontic free choice (**deoFC**) under deontic modals, if licensed.

In (18), the English indefinite *somebody* gives rise to an unconventionalized ignorance implicature, which can however be cancelled by adding the continuation 'Guess who?' or 'Namely John.', and is therefore not taken as an EI.

(18) Somebody arrived late. (Guess who? / Namely John.)
  a. Conventional meaning: Somebody arrived late.
  b. Ignorance implicature: The speaker doesn't know who.

In contrast, *shenme* in Mandarin is an EI (Y.-h. A. Li 1992; J.-W. Lin 1998), and can appear in its bare form and with a numeral classifier. In both forms, *shenme* leads to an ignorance inference that cannot be cancelled.[10]

(19) Ta gen (yi ge) shenme ren jiehun-le. #Ni cai shi shui? / #Jiushi Zhangsan.
  she with (one CL) what person marry-PRF you guess be who / namely Zhangsan
  'She married somebody, and the speaker doesn't know who.'

In what follows, I will firstly introduce the four functions of EIs as identified by Aloni and Port (2010, 2015), discuss the distribution of bare *shenme* and non-bare *shenme* with respect to these functions, and compare them with other EIs cross-linguistically.

1.2.1 The specific unknown function (SU)

The **SU** function is triggered when EIs are not embedded and have an obligatory ignorance effect: namely, the speaker does not know what the EI refers to while the EI is used specifically. Both bare *shenme* and non-bare *shenme* can be found to license the **SU** function, as in (19) and (20).

(20) Zhangsan mai-le (san ben) shenme shu.
  Zhangsan buy-PRF (three CL) what book
  'Zhangsan bought three books / (a) book(s) (and I don't know which book(s)).' **SU** ✓

Based on the quantificational force that the ignorance/modal effect might have, Aloni and Franke (2013), Aloni and Port (2010, 2015), and Alonso-Ovalle and Menéndez-Benito (2010) distinguish between partial variation and total variation (also known as free choice) as defined in

[10] It is worth noting that *shenme* and many other EIs also have an indifference reading, on which the identity of the EI's referent, presumably known by the speaker, does not matter in the discourse (Liu and Yu'an Yang 2021). Also, most accounts of EIs do not explain the indifference reading. One exception is Aloni (2007a). For the present purpose, I will not further discuss the indifference reading of *shenme* in the thesis.

(i) *Context: A is trying to explain to B how to open a bank account in America.*
  Hai, suibian zhao ge shenme difang (pengmian), wo gei ni nong liang zhang dongxi (shenqing biao)
  hey just find CL what place meet.up I to you get two CL thing application form
  guoqu, daoshi ni tian, yiji, jiu wan le.
  over then you fill.in send PART over ASP
  'That's easy, (we) meet up somewhere, I get you two application forms, you fill it in, send it out, and it's done.'
  (Liu and Yu'an Yang 2021)

(21): Partial variation only requires to have more than one possible alternatives, whereas for total variation, all the alternatives must qualify as a possible option.

(21) a. Partial variation: $\exists x \exists y (\Diamond \phi(x) \wedge \Diamond \phi(y) \wedge x \neq y)$
b. Total variation: $\forall x \Diamond \phi(x)$ (Aloni and Franke 2013)

To tear partial and total variation apart, Alonso-Ovalle and Menéndez-Benito (2010) provide the following 'hide and seek' scenario.

(22) Scenario: María, Juan, and Pedro are playing hide-and-seek in their country house. Juan is hiding. María and Pedro haven't started looking for Juan yet. Pedro believes that Juan is not hiding in the garden or in the barn: he is sure that Juan is inside the house. Furthermore, Pedro is sure that Juan is not in the bathroom or in the kitchen. As far as he knows, Juan could be in any of the other rooms in the house.

In this scenario, as Pedro believed Juan not to hide in the bathroom or in the kitchen, the alternatives for Juan to hide in these two locations are not epistemically possible for Pedro. The felicity for Pedro to utter (23) suggests that the ignorance effect triggered by both bare and non-bare *shenme* episodically is partial rather than total variation.

(23) Juan cang zai fangzi de (yi ge) shenme fangjian.
Juan hide in house MOD (one CL) what room
'Juan is hiding in some room of the house.'

1.2.2 The epistemic unknown function (epiU)

When embedded under epistemic modals, EIs also trigger a similar ignorance effect of a partial variation kind, which is characterized as the **epiU** function.

The following examples are from Law (2019), where she identifies both bare and non-bare *shenme* to be felicitous in the scope of the epistemic modal *keneng* 'possibly' (24). Furthermore, the context given in (25) excludes the other cities except London and Berlin as alternatives for Peter to visit, and induces a partial variation environment similar to the 'hide and seek' scenario. The infelicity of the response *budui* 'no' indicates that the *shenme* sentence in (24) is still felicitous even in the newly added context. Therefore, the **epiU** function licensed by *shenme* under epistemic modals is also partial variation.

(24) *Context: John and Mary knew that Peter went on a trip last week, but they did not know where he went. They were talking about where Peter could have gone. John suggested:*
Ta keneng qu-le (yi ge) Ouzhoude shenme chengshi.
he possibly go-PRF (one CL) European what city
'He could have gone to an European city.' **epiU** ✓

(25) *Context: Mary knew that Peter stayed with a friend during his trip, and Peter only had two overseas friends, one in London and one in Berlin. So, she added:*
#Bu dui. Ta zhi keneng qu-le Lundun huo Bolin.
not right he only possibly go-PRF London or Berlin
'No, he could only have gone to London or Berlin.'

1.2.3 The negative polarity function (NPI)

While the aforementioned two functions are generally licensed by all the EIs, which, by definition, have a conventionalized ignorance inference of a partial variation kind both in specific uses, and additionally also under epistemic modals, the functions of **NPI** and **deoFC** are not (Aloni and Port 2010, 2015). In the case of Mandarin, only bare *shenme* can appear in negative contexts to have a narrow scope existential meaning taken as the **NPI** function (26-a), while an NPI-like interpretation such as 'Zhangsan didn't buy any three books' is never available for non-bare *shenme* (26-b). Notably, the only interpretation of (26-b), if judged felicitous, is from the **SU** use where the speaker does not know which three specific books were bought by Zhangsan.

(26) a. Zhangsan mei mai shenme shu.
Zhangsan NEG buy what book
'Zhangsan didn't buy any book.' **NPI** ✓
b. ?Zhangsan mei mai san ben shenme shu.
Zhangsan NEG buy three CL what book
'Zhangsan didn't buy any three books.' **NPI**
'Zhangsan didn't buy three specific books (and I don't know which three). **SU** ✓

It is worth noting that in addition to the negative marker *mei* in (26), there are another two forms of negation in Mandarin using *bu* and *bushi* (C. Li and Thompson 1981). As for the distinction between *bu* negation and *mei* negation, Hsieh (2001) argues that the former is used to deny non-dynamic situations, whereas the latter to deny dynamic situations. According to her, negation using *bu* has habitual (27-a-i), volitional (27-a-ii), and future (27-a-iii)[11] interpretations, all associated with a non-dynamic situation where the state will continue without additional interference. In contrast, *mei* negation in (27-b) denies the change of a state, namely a dynamic situation for Zhangsan to change from not going to going.

(27) a. Zhangsan bu qu.
Zhangsan not go
(i) 'Zhangsan doesn't go.'
(ii) 'Zhangsan doesn't want to go.'
(iii) 'Zhangsan will not go.'
b. Zhangsan mei qu.
Zhangsan NEG go
'Zhangsan didn't go.'

From a more practical perspective, the reason that I adopt *mei* rather than *bu* negation throughout the thesis is that *bu* seems generally odd with non-bare nouns in the scope of its negation. For example, the oddity of (28), as some Mandarin native speakers point out, is resulted from their tendency to interpret *liang zhi mao* 'two cats' and *liang ge da renwu* 'two famous people' to be 'two specific cats' and 'two specific famous people', while non-bare nouns without demonstratives added on are normatively taken to be indefinite (L. L.-S. Cheng and Sybesma 1999).[12]

[11] Hsieh (2001) argues that the future interpretation is derived from the volitional interpretation. For example in (27), if Zhangsan does not want to go, it follows that he will not go.

[12] However, for some Mandarin native speakers, replacing *bu* by *mei* in (28) seems to slightly increase its felicity. I will leave this observation to be checked and analyzed for future research.

(i) a. ?Wo mei xihuan liang zhi mao.
I NEG like two CL cats
'I don't like two cats.'
b. ?Ta mei renshi liang ge da renwu.
S/he NEG know two CL big person
'S/he doesn't know two famous people.'

(28) a. *Wo bu xihuan liang zhi mao.
I not like two CL cats
'I don't like two cats.'
b. *Ta bu renshi liang ge da renwu.
S/he not know two CL big person
'S/he doesn't know two famous people.'

The other form of negation in Mandarin by *bushi* is often contrastive, where *bushi* is the negative form of the focus marker *shi* when not used as a copulative verb (Yeh 1995). For example, the predicate *mai* 'buy' in (29-a), the subject Zhangsan in (29-b), and the object *shu* 'book' in (29-c), are all focus marked items following *bushi*. As negation applies only to focus marked items while leaving the remainder unnegated (Beaver and Clark 2008), (29-a), (29-b), and (29-c) result in the following interpretations respectively: Zhangsan selling instead of buying book(s), Lisi instead of Zhangsan buying book(s), and Zhangsan buying notebook(s) instead of book(s). Both bare *shenme* and non-bare *shenme* in *bushi* negation do not license the **NPI** function, but give rise to an ignorance effect similar to **SU**, where there are some specific book(s) that are not known to the speaker.

(29) a. Zhangsan bushi mai-le (san ben) shenme shu.
Zhangsan not.be buy-PRF (three CL) what book
'It is not the case that Zhangsan bought three books / (a) book(s).'
⇝ 'Rather, Zhangsan sold three books / (a) book(s).'
b. Bushi Zhangsan mai-le (san ben) shenme shu.
not.be Zhangsan buy-PRF (three CL) what book
'It is not Zhangsan that bought three books / (a) book(s).'
⇝ 'Rather, Lisi bought three books / (a) book(s).'
c. Zhangsan mai-de bushi (san ben) shenme shu.
Zhangsan buy-MOD not.be (three CL) what book
'It is not three books / (a) book(s) that Zhangsan bought.'
⇝ 'Rather, Zhangsan bought three notebooks / (a) notebook(s). '

1.2.4 The deontic free choice function (deoFC)

Aloni and Port (2010, 2015) identify the **deoFC** function to be the free choice inference triggered by EIs under deontic modals. Following the observation from J.-W. Lin (1998) that *shenme* generally requires a numeral classifier for it to be properly licensed in the scope of deontic modals[13], Law (2019) provides the following example (30), judging only non-bare *shenme* to be felicitous under deontic modals. However in Chapter 4 of the thesis, I will revise the judgement from Law (2019) by discussing another example for bare *shenme* to be embedded in the scope of a deontic necessity modal.

(30) a. *Zilu yao/keyi kan shenme shu.
Zilu must/can read what book
'Zilu must/can read some book(s).' **deoFC #**
b. Zilu yao/keyi kan yi ben shenme shu.
Zilu must/can read one CL what book
'Zilu must/can read some book.'

In addition, Law (2019) shows that the modal inference triggered by non-bare *shenme* under

[13]Note that J.-W. Lin (1998) treats deontic modals in the category of future-related predicates.

deontic modals is total variation. As exemplified by the felicity of the response *bushi* 'no' in (32), limiting the cities for their visit to only London and Berlin would result in the rejection of (31). It follows that the use of *shenme* under deontic modals gives rise to a free choice inference, which in (31) requires all the European cities to qualify as a possible option.

(31) *Context: John and Mary were planning a trip to Europe. John suggested:*
Women keyi qu yi ge Ouzhoude shenme chengshi.
we can go one CL European what city
'We can go to an European city (whichever will work).' **deoFC** ✓

(32) *Context: Mary knew that they could only visit an European city where they had a friend to stay with. Since they only had a friend in London and a friend in Berlin, she added:*
Bu dui. Women zhi keyi qu Lundun huo Bolin.
no right we only can visit London or Berlin
'No, we can only go to London or Berlin.'

1.2.5 Cross-linguistic comparison

If we for now ignore the form distinction between bare and non-bare *shenme*, but treat both as representations of the Mandarin EI while one with and one without a numeral classifier, it can been seen from (33) that *shenme* is cross-linguistically similar to German *irgendein*. Specifically, both Mandarin *shenme* and German *irgendein* can be found in episodic sentences (33-a), under epistemic (33-b) and deontic (33-d) modals, and in negative contexts (33-c), licensing all the EI functions of **SU**, **epiU**, **NPI**, and **deoFC** as identified by Aloni and Port (2010, 2015).

(33) German *irgendein*:

a. *Irgendein* Student hat angerufen.
Some student has called
'Some student called (and I don't know who).' **SU** ✓

b. *In 'hide and seek' scenario:*
Juan muss in *irgendeinem* Zimmer im Haus sein.
Juan must in some room in.the house be
'Juan must be in some room of the house (and I don't know which room).' **epiU** ✓

c. Niemand hat *irgendeine* Frage beantwortet.
Nobody has some question answered.
'Nobody answered any question.' **NPI** ✓

d. Maria muss *irgendeinen* Arzt heiraten.
Maria must some doctor marry
'Maria must marry a doctor (and any doctor is possible).' **deoFC** ✓
(Aloni and Port 2010, 2015)

In contrast, there are also EIs triggering only some rather than all of the functions, for example, the Spanish EI *algún* (34) and the Italian EI *un qualche* (35). According to Alonso-Ovalle and Menéndez-Benito (2010, 2017), *algún* can license the functions of **SU**, **epiU**, and **NPI**, as shown by (34-a), (34-b), and (34-c) respectively. However, when embedded under deontic modals, *algún* still triggers partial variation rather than total variation as required by **deoFC**, as (34-d) is also felicitous in the context where some of the candidates are not qualified.

(34) Spanish *algún*:

a. María sale con *algún* estudiante.
María goes.out with some student

'María is dating some student (and I don't know who).' **SU** ✓

b. *In 'hide and seek' scenario:*
Juan tiene que estar en *alguna* habitación de la casa.
Juan has to be in some room of the house
'Juan must be in some room of the house (and I don't know which room).' **epiU** ✓

c. No es verdad que Juan salga con *alguna* chica del departamento de lingüística.
not is true that Juan goes.out with some girl from.the department of linguistics
'Juan is not dating any of the girls in the linguistics department.' **NPI** ✓

d. El departamento puede contratar a *alguno* de los candidatos que han solicitado el puesto.
The department can hire some of the candidates who have applied.for the position
'The department can hire some (#any) of the candidates that have applied to the position.' **deoFC** #

(Alonso-Ovalle and Menéndez-Benito 2010, 2017)

The Italian EI *un qualche*, also licensing the **SU** and **epiU** functions as exemplified by (35-a) and (35-b), is found to be deviant under negation (35-c), and in this way fails to exhibit the function of **NPI**. Combining *un qualche* with deontic modals, though being grammatical, only triggers an ignorance effect of **SU** where *un qualche* is read specifically and placed outside the scope of the deontic modal. For example, *un qualche* in (35-d) can only refer to a specific doctor unknown to the speaker, whereas the other interpretation for Mary to marry any doctor as characterized by **deoFC** is not present.

(35) Italian *un qualche*:

a. Maria ha sposato *un qualche* professore.
Maria has married a some professor
'Maria married some professor (and I don't know who).' **SU** ✓

b. *In 'hide and seek' scenario:*
Juan deve essere in *una qualche* stanza della casa.
Juan must be in a some room of.the house
'Juan must be in some room of the house (and I don't know which room).' **epiU** ✓

c. *Non ho risposto a *una qualche* domanda.
not I.have answered to a some question
#'I didn't answer any question.' **NPI** #

d. Maria deve sposare *un qualche* dottore.
Mary must marry a some doctor
'There is some doctor that Mary must marry (and I don't know who).'
#'Mary must marry a doctor (and any doctor is possible).' **deoFC** #

(Aloni and Port 2010, 2015)

The variety of EIs cross-linguistically can be seen from Table 1.1. While Spanish *algún* and Italian *un qualche* qualify for the **SU** and **epiU** functions, and Spanish *algún* additionally for **NPI** as well, the Mandarin EI *shenme* is similar to German *irgendein* in that both allow for all the functions as characterized by Aloni and Port (2010, 2015).

However, as pointed out by Alonso-Ovalle and Menéndez-Benito (2017), the proposal of Aloni and Port (2010, 2015) to account for EIs in the conceptual cover approach overlooks the behavior for an EI to license the narrow scope interpretation when combined with a universal

	SU	epiU	NPI	deoFC
Mandarin *shenme*	✓	✓	✓	✓
German *irgendein*	✓	✓	✓	✓
Spanish *algún*	✓	✓	✓	#
Italian *un qualche*	✓	✓	#	#

Table 1.1: Cross-linguistic comparison

quantifier.[14] In the next sections, I will discuss such a use, which I take as co-variation (**co-var**), and additionally the use of EIs to license also constituent questions.

1.2.6 The co-variation use (co-var)

In addition to the four EI functions as characterized by Aloni and Port (2010, 2015), Alonso-Ovalle and Menéndez-Benito (2017) notice the scope behavior of an EI when combined with a universal quantifier. For example, in (36), the Spanish EI *algún* can be interpreted both outside and inside the universal quantifier *todo* 'all'. In the wide scope interpretation, *algún* scopes over the universal quantifier, giving rise to the meaning in the use of **SU** that all the professors are talking to the same student who the speaker cannot identify. As for the narrow scope interpretation, *algún* is placed within the scope of the universal quantifier, and there are different students with whom different professors are talking, while the speaker may know exactly which professors are talking to which students. Following Alonso-Ovalle and Menéndez-Benito (2017), I will refer to the narrow scope interpretation for EIs when combined with a universal quantifier as the use of **co-var**.

(36) Todos los profesores están hablando con algún estudiante.
all the professors are talking with some student
'Every professor is talking to some student.'
(Alonso-Ovalle and Menéndez-Benito 2017)

The Mandarin EI *shenme*, in its both forms, can also exhibit such a scope behavior as Alonso-Ovalle and Menéndez-Benito (2017) find for Spanish *algún*. As shown by (37), both bare and non-bare *shenme* combined with the universal quantifier *mei* 'every' can be read in two ways. On the wide scope reading, there is only one book (non-bare *shenme*) or only one combination of books (bare *shenme*) bought by all the people which the speaker fails to identify. On the narrow scope reading, there are at least two books (non-bare *shenme*) or two combinations of books (bare *shenme*) being bought.

(37) Mei ge ren dou mai-le (yi ben) shenme shu.
every CL person PART buy-PRF one CL what book
'Everyone bought one book / (a) book(s).'
⇝ Wide scope reading: There is/are (a) specific book(s) bought by all the people, and I don't know which book(s). **SU** ✓
⇝ Narrow scope reading: Different people bought different books. There are at least two different books / two combinations of books being bought. **co-var** ✓

[14] See Chapter 2 for details.

1.2.7 The question use

As *shenme* is itself also a *wh*-word in Mandarin, it is found that a question reading can also be licensed in the forms of both bare *shenme* and non-bare *shenme*. For example, if not interpreted as a declarative with an ignorance inference as triggered episodically in the **SU** function, (38) is taken as a constituent question asking what books Zhangsan bought.

(38) Zhangsan mai-le (san ben) shenme shu?
Zhangsan buy-PRF three CL what book
'What three books / book(s) did Zhangsan buy?' **Q** ✓

Apart from Mandarin *shenme*, there are also examples in other languages where their *wh*-words have such a dual use – as indefinites in declaratives, and as question words in interrogatives. For example, as shown in (39), Dutch *wat*[15] can be taken either as an existential indefinite meaning 'something' (39-a), or as a question word 'what' to license the constituent question in (39-b).

(39) a. Miranda heeft wat gegeten.
Miranda has what eaten
'Miranda has eaten something.' **SU** ✓
b. Wat heeft Miranda gegeten?
what has Miranda eaten
'What has Miranda eaten?' **Q** ✓
(Hengeveld et al. 2022)

1.3 Summary

The following table summarizes the distribution of bare and non-bare *shenme* with respect to the four EI functions as identified by Aloni and Port (2010, 2015), and additionally two other uses also found available for EIs. In Chapter 2, I will review three representative analyses of EIs using the alternative based approach (Alonso-Ovalle and Menéndez-Benito 2010; Kratzer and Shimoyama 2002), the exhaustification based approach (Chierchia 2006, 2013; Chierchia and Liao 2015; Fox 2007; Law 2019), and the conceptual cover approach (Aloni and Port 2010, 2015). Specifically, I will argue that none of these approaches is sufficient to capture Mandarin *shenme*.

	SU	epiU	NPI	deoFC	co-var	Q
Bare *shenme*	✓	✓	✓	#[16]	✓	✓
Non-bare *shenme*	✓	✓	#	✓	✓	✓

Table 1.2: Summary

[15]Note that Hengeveld et al. (2022) argue in their analysis for Dutch *wat* not to be taken as an EI, but in their term as a *quexistential*. Their argument is based on the indifference reading as in (i) that the speaker knows what she has eaten.

(i) Ik heb wat gegeten.
I have what eaten
'I have eaten something.' (Hengeveld et al. 2022)

[16]I will later revise the judgement in Chapter 4.

Chapter 2

Previous Approaches

Chapter 1 introduces EIs and specifically the functions and uses that EIs would possibly license in varied environments. In the case of the Mandarin EI *shenme*, there are several observations worth highlighting, summarized as follows.

(A) *Shenme* triggers a conventionalized ignorance inference in episodic contexts.

(B) When combined with a universal quantifier, *shenme* is found to license both the wide scope and narrow scope readings. Specifically, *shenme* gives rise to an ignorance effect on the wide scope reading, while leads to co-variation on the narrow scope reading.

(C) Under deontic modals, (non-bare) *shenme* can license a free choice effect, whereas under epistemic modals, *shenme* induces partial rather than total variation.

(D) In negative contexts, (bare) *shenme* can induce a narrow scope existential meaning.

(E) *Shenme* can be used both as an EI and as an interrogative word.

(F) Bare *shenme* and non-bare *shenme* as two forms of *shenme* have slightly different distributions with respect to the behaviors of EIs – bare *shenme* seems odd under deontic modals, whereas non-bare *shenme* could not induce an NPI-like interpretation.

In this chapter, I will review three representative approaches to the puzzle of *shenme* and EIs in general, including the alternative based approach (Alonso-Ovalle and Menéndez-Benito 2010; Kratzer and Shimoyama 2002), the exhaustification based approach (Chierchia 2006, 2013; Chierchia and Liao 2015; Fox 2007; Law 2019), and the conceptual cover approach (Aloni and Port 2010, 2015). Roughly, the former two are pragmatic approaches that derive the ignorance inference of EIs as a certain implicature[1], whereas the last one holds that the ignorance inference is conventionalized and encoded in the semantics of EIs.

It is worth noting that most approaches to EIs, to the best of my knowledge, are targeted at European languages with morphological number marking, and in this way fail to account for the distinction between the two forms of Mandarin *shenme* (F).

In what follows, I will argue that none of the aforementioned approaches is sufficient to capture the Mandarin EI *shenme* even despite its form distinction. Specifically, the two pragmatic accounts fail to account for (A) and (C), as they analyze the behaviors of EIs in terms of modal inferences and would predict a uniform behavior for a particular EI when embedded in the scope of both epistemic and deontic modals, and in addition also for the episodic contexts where they have to assume the presence of a covert necessity modal to derive the ignorance inference. To be more specific, they incorrectly predict different kinds of variation for different indefinites:

[1] Note however that the implicatures derived in the exhaustification based approach are grammatical.

total variation for domain wideners like the German EI *irgendein* and partial variation for anti-singleton indefinites such as Spanish *algún*. The conceptual cover approach, in contrast, requires the ignorance inference to result from a compulsory shift of conceptual cover in the semantics of EIs, and cannot be used for the narrow scope reading in (B) where the speaker may know exactly the referent of an EI. Also, the exhaustification based approach and the conceptual cover approach do not have an account for questions as in (E).

Note that I will in the thesis analyze the Mandarin EI *shenme* in the team semantics framework by Aloni and Degano (2022, 2023), but for convenience will postpone the discussion to the next chapter.

2.1 Alternative based approach

The alternative based approach is proposed by Kratzer and Shimoyama (2002) as a pragmatic account treating the modal inferences of EIs to be conversational implicatures based on Gricean reasoning. In their analysis, EIs are taken to create Hamblin sets of alternatives, while the ignorance inference, the partial or total variation under modals, and the disappearance of such implicatures in negative contexts, as licensed by EIs, can be computed from alternatives in order for the speaker to avoid a false claim or to avoid a false exhaustivity inference.

The reason for Kratzer and Shimoyama (2002) to treat the epistemic effect of EIs as a conversational implicature is from (1). The German EI *irgendein* is found to be combined with a deontic modal *müssen* 'must' without licensing either the ignorance inference or the free choice effect. They take (1) as evidence for the modal inferences of EIs to be cancellable.

(1) Du musst irgendeinen Arzt heiraten, und das darf niemand anders sein als Dr. Heintz.
You must some doctor marry and that may nobody else be than Dr. Heintz
'You must marry some doctor or other, and it can't be anybody but Dr. Heintz.'

Similarly, Alonso-Ovalle and Menéndez-Benito (2010) also find (2) for the Spanish indefinite *algún*, where the speaker adds to show her actually knowing of who María married, and in this case cancels the ignorance inference of *algún*. In addition, they argue that the ignorance inference licensed by EIs can be reinforced without redundancy. For example in (3), it is felicitous to repeat the speaker's ignorance of who María married despite the use of *algún* already.[2]

(2) María se casó con algún estudiante de lingüística. De hecho, sé exactamente con quién.
María PART married with some student of linguistics In fact I.know exactly with whom
'María married a linguistics student. In fact, I know exactly who!'

(3) María sale con algún estudiante del departamento de lingüística, pero no
María goes.out with some student of.the department of linguistics but not

[2]It seems that the ignorance inference of the Mandarin EI *shenme* can also be reinforced without creating an effect of redundancy, as in (i).

(i) Zhangsan mai-le (yi ben) shenme shu. Wo bu zhidao shi shenme shu.
Zhangsan buy-PART (one CL) what book I not know be what book
'Zhangsan bought some book(s), and I don't know which book(s).'

sé con quién.
I.know with whom
'María is dating some student in the linguistics department, but I don't know who.'

It is worth noting that the aforementioned observations by Alonso-Ovalle and Menéndez-Benito (2010) and Kratzer and Shimoyama (2002), though indeed to some extent challenging the semantic view in support of taking the ignorance effect of EIs to be conventional and non-cancellable, do not form a knock-down argument for the inference to be taken as a conversational implicature. Specifically, the pragmatic account cannot explain the infelicity of adding the continuation *Rat mal wer?* 'Guess who?' in (4), while treating the ignorance inference pragmatically would result in its cancellation and predict the well-formedness of (4).[3][4]

(4) Irgendjemand hat angerufen. #Rat mal wer?
some.somebody has called guess PART who
'Somebody called, and the speaker doesn't know who.'

At the current stage, it seems still not clear from linguistic examples alone if the ignorance inference of EIs arises as a conversational implicature based on Gricean reasoning, or as a result of its own semantics. I will leave the reanalysis of the aforementioned examples for future work, and for the present purpose, be open to both options and only review the previous approaches of EIs from the theoretical perspective.

2.1.1 Key ingredients

According to the alternative based approach, in addition to the assertive content as contributed by the logical forms of EIs, they also generate some set of alternatives from which the modal inferences of EIs can be derived as implicatures. Kratzer and Shimoyama (2002) take the German EI *irgendein* as a maximal domain widener, which widens the domain to denote the set of all the individuals with respect to a property. For example, *irgendein man* denotes the set of all the men as exemplified by (5-a). Indefinites are in addition assumed to associate with a certain operator closing the scope of the set to select the alternatives. German *irgendein* is taken to associate with only the existential propositional operator $[\exists]$, and *irgendein man walks* gives rise to a meaning that there exists some man walking by applying $[\exists]$ to the set of alternatives, as shown in (5-b).

(5) In Kratzer and Shimoyama (2002):
a. *irgendein man*: $\{x : x \in D \wedge Man(x)\}$

[3] In addition, Alonso-Ovalle and Menéndez-Benito (2010) and Kratzer and Shimoyama (2002) take the disappearance of the ignorance inference of EIs under negation, as exemplified by (i) and (ii), to be the most reliable indication of its conversational implicature status. According to them, "cancellation and disappearance under downward entailing contexts are the hallmarks of quantity-based conversational implicatures" (Alonso-Ovalle and Menéndez-Benito 2010). This is however not the case. I will show that the semantic account by Aloni and Port (2010, 2015) also predicts the ignorance effect of EIs to disappear in downward entailing contexts while not treating it as a conversational implicature.

(i) Niemand musste irgendjemand einladen.
nobody had.to some.somebody invite
'Nobody had to invite anybody.'

(ii) No es verdad que Juan salga con alguna chica del departmento de lingüística.
not is true that Juan dates with some girl from.the department of linguistics
'Juan is not dating any girl in the linguistics department.'

[4] In the alternative based approach by Alonso-Ovalle and Menéndez-Benito (2010) on the Spanish EI *algún*, they propose an anti-singleton constraint for *algún* as an existential ranging over a non-singleton domain. With their assumption followed, the infelicity of (4) may be explained by the violation of its anti-singleton constraint.

b. $[\exists]$(*irgendein man walks*): $[\exists](d_1$ is a man walking, d_2 is a man walking, d_3 is a man walking, ...$)$ = {that there is a man walking}, where $d_1, d_2, d_3, \ldots \in [\![$*irgendein man*$]\!]$.

As for how Kratzer and Shimoyama (2002) derive implicatures from the set of alternatives, consider the modal sentence in (6-a), with the semantic contribution of the sentence in (6-b).

(6) a. Maria muss *irgendeinen* Arzt heiraten.
Maria must some doctor marry
'Maria must marry a doctor (and any doctor is possible).'

b. $[\exists]$(*Maria must marry irgendein doctor*): $[\exists](\Box P(d_1), \Box P(d_2), \Box P(d_3), \ldots)$, where $d_1, d_2, d_3, \ldots \in [\![$*irgendein doctor*$]\!]$ and P is a property of being a doctor that Maria marries.

c. Free choice as implicature: for all $d \in [\![$*irgendein doctor*$]\!]$, it is possible that Maria marries d.

The alternatives generated by *irgendein* according to Kratzer and Shimoyama (2002) can be illustrated by Figure 2.1, where $d_1, d_2, d_3, \ldots$ are individuals from the maximal domain and the existential propositional operator $[\exists]$ can operate on the propositions $\Box P(d_1), \Box P(d_2), \Box P(d_3), \ldots$ generated by them. Their deriving of the implicatures from the set of alternatives is based on a two-fold computation. Suppose that a narrower set of alternatives $\{d_1\}$ is picked rather than the maximal domain $\{d_1, d_2, d_3, \ldots\}$ from the table. The reason that the speaker insists on using *irgendein* while not opting for $\{d_1\}$ may be the case that the stronger claim $\Box P(d_1)$ is false, or alternatively, that $\Box P(d_1)$ is true, but its exhaustivity inference $\neg[\Box P(d_2) \vee \Box P(d_3) \vee \ldots]$ is false. In this way, the implicatures of *irgendein* can be computed following Gricean reasoning on why the maximal domain has to be taken, and according to Kratzer and Shimoyama (2002), this is to avoid either a false claim or a false exhaustivity inference.

d_1
d_2
d_3
...

(a) Maximal domain

$[\exists]$

d_1 walks
d_2 walks
d_3 walks
...

(b) Semantic contribution of the sentence

$$\Box P(d_1) \rightarrow [\Box P(d_2) \vee \Box P(d_3) \vee \ldots]$$
$$\Box P(d_2) \rightarrow [\Box P(d_1) \vee \Box P(d_3) \vee \ldots]$$
$$\Box P(d_3) \rightarrow [\Box P(d_1) \vee \Box P(d_2) \vee \ldots]$$
$$\ldots$$
$$[\Box P(d_1) \vee \Box P(d_2)] \rightarrow [\Box P(d_3) \vee \ldots]$$
$$[\Box P(d_1) \vee \Box P(d_3)] \rightarrow [\Box P(d_2) \vee \ldots]$$
$$[\Box P(d_2) \vee \Box P(d_3)] \rightarrow [\Box P(d_1) \vee \ldots]$$
$$\ldots$$

(c) To avoid inferences

Figure 2.1: German *irgendein* in Kratzer and Shimoyama (2002)

Alonso-Ovalle and Menéndez-Benito (2010), also using the alternative based approach, propose another way to generate alternatives by a subset selection function mechanism. In their analysis, EIs can take their domain of quantification as a subset of the maximal domain by their subset selection function, and alternatives are defined as sets not picked out by the subset selection function. Put differently, alternatives are taken by Alonso-Ovalle and Menéndez-Benito

(2010) as sets which the EI cannot quantify over. For example, the Spanish EI *algún* is in their analysis an "anti-singleton" indefinite requiring its domain to consist of more than one individual, and the alternatives with respect to *algún* are all the singleton subsets of the maximal domain.

(7) Subset selection functions:

a. Singleton subset selection functions: f is a singleton subset selection function iff for any set P, $f(P)$ is a singleton.

b. Anti-singleton subset selection functions: f is an anti-singleton subset selection function iff for any set P, $f(P)$ is not a singleton.

(8) In Alonso-Ovalle and Menéndez-Benito (2010):

a. *algún*: $\lambda f.\lambda P.\lambda Q.\textbf{anti-singleton}(f).\exists x[f(P)(x) \wedge Q(x)]$

b. *algún estudiante*: $\lambda Q.\exists x[x \in f(Student) \wedge Q(x)]$

c. Anti-singleton constraint: $|f(Student)| > 1$

As illustrated by Figure 2.2, if the maximal domain is taken as $\{d_1, d_2, d_3, \ldots\}$ where $d_1, d_2, d_3, \ldots$ are all students, then *algún* with the anti-singleton constraint on its domain of quantification can pick out any non-singleton subset by the subset selection function f from the set of students. Alternatives are defined as sets in competition with the quantificational domains of *algún*, namely all the singleton subsets of the maximal domain.

(a) Maximal domain	(b) Subsets by *algún*	(c) Alternatives
	$\{d_1, d_2\}$	
	$\{d_1, d_3\}$	$\{d_1\}$
	$\{d_2, d_3\}$	$\{d_2\}$
	$\{d_1, d_2, d_3\}$	$\{d_3\}$
$\{d_1, d_2, d_3, \ldots\}$	$\ldots$	$\ldots$

Figure 2.2: Spanish *algún* in Alonso-Ovalle and Menéndez-Benito (2010)

Note that the way for Alonso-Ovalle and Menéndez-Benito (2010) and Kratzer and Shimoyama (2002) to derive modal inferences of EIs as implicatures are essentially similar. Kratzer and Shimoyama (2002) compute the implicatures of *irgendein* according to Gricean reasoning that any narrower domain rather than the maximal one would lead to either a false claim or a false exhaustivity inference. Alonso-Ovalle and Menéndez-Benito (2010) also follow to take the avoidance of false claims and false exhaustivity inferences to be the reasons for implicatures. For example, the analysis by Alonso-Ovalle and Menéndez-Benito (2010) of the German EI *irgendein* would require only the set of maximal domain to be picked out by its subset selection function. The alternatives are in this way taken as all the proper subsets of the maximal domain, as illustrated by Figure 2.3.

In the next sections of the thesis when reviewing the alternative based approach, I will follow the analysis by Alonso-Ovalle and Menéndez-Benito (2010) to treat alternatives as subsets of the maximal domain which the EI cannot quantify over. Specifically, I take the implicatures to be computed by the following scheme, where the antecedent of the implication serves to negate the false claim and the consequent to negate the false exhaustivity inference by taking the alternative D' from the maximal domain $D = \{a, b, c\}$. As for German *irgendein*, the alternative D' can be taken as any proper subset of the maximal domain D, while Spanish *algún* additionally requires it to be singleton.

(a) Maximal domain	(b) Subset by *irgendein*	(c) Alternatives
$\{d_1, d_2, d_3, \ldots\}$	$\{d_1, d_2, d_3, \ldots\}$	$\{d_1\}$ $\{d_2\}$ $\{d_3\}$ $\ldots$ $\{d_1, d_2\}$ $\{d_1, d_3\}$ $\{d_2, d_3\}$ $\ldots$

Figure 2.3: German *irgendein* in Alonso-Ovalle and Menéndez-Benito (2010)

(9) Implicature (where D is the set of all the doctors):

a. Maria must marry *irgendein* doctor:
$\bigvee_{x \in D'} \Box P(x) \to \bigvee_{x \in D \setminus D'} \Box P(x)$, for all D' such that $D' \subset D$

b. Maria must marry *algún* doctor:
$\bigvee_{x \in D'} \Box P(x) \to \bigvee_{x \in D \setminus D'} \Box P(x)$, for all D' such that $D' \subset D \wedge |D'| = 1$

Note that the alternative based approach is able to capture the **co-var** and **NPI** uses of EIs (see Alonso-Ovalle and Menéndez-Benito (2010) for details), and in addition is the only approach out of the three that has a straightforward account of question uses of indefinites based on Hamblin's question semantics (Hamblin 1973). However, such an approach is problematic with respect to its explanation of **SU**, **epiU**, and **deoFC**. As we will move on to see in the following sections, the inferences derived from a particular EI in the alternative based approach are the same regardless of its contexts taken to be episodic, under epistemic modals, or under deontic modals. The reason is that the alternative based approach essentially computes the inferences triggered by an EI in terms of the quantificational domain that it can possibly license – or as in Alonso-Ovalle and Menéndez-Benito (2010), based on the constraint in the semantic representation of an EI to be imposed on its domain of quantification.

2.1.2 Modal

While EIs are found to license partial variation under epistemic modals and possibly total variation under deontic modals, a problem for pragmatic accounts as identified by Aloni and Port (2010, 2015) is that they typically predict a uniform behavior for an EI under both modals. For example, according to the alternative based approach (Alonso-Ovalle and Menéndez-Benito 2010; Kratzer and Shimoyama 2002), the modal inference is always partial variation for Spanish *algún* and total variation for German *irgendein* regardless of the classes of modality.

(10) German *irgendein*:

a. Assertion: $\Diamond \exists x[x \in D \wedge P(x)]$

b. Implicature: $\Diamond P(a) \to \Diamond P(b) \vee \Diamond P(c), \Diamond P(b) \to \Diamond P(a) \vee \Diamond P(c), \Diamond P(c) \to \Diamond P(a) \vee \Diamond P(b), \Diamond P(a) \vee \Diamond P(b) \to \Diamond P(c), \Diamond P(a) \vee \Diamond P(c) \to \Diamond P(b), \Diamond P(b) \vee \Diamond P(c) \to \Diamond P(a)$

c. Inference: $\forall x[x \in D \wedge \Diamond P(x)]$

(11) Spanish *algún*:

a. Assertion: $\Diamond \exists x[x \in D \wedge P(x)]$

b. Implicature: $\Diamond P(a) \to \Diamond P(b) \vee \Diamond P(c), \Diamond P(b) \to \Diamond P(a) \vee \Diamond P(c), \Diamond P(c) \to \Diamond P(a) \vee \Diamond P(b)$

c. Inference: $\exists x \exists y[x, y \in D \wedge x \neq y \wedge \Diamond P(x) \wedge \Diamond P(y)]$

The aforementioned formalization takes German *irgendein* and Spanish *algún* to be embedded in the scope of possibility modals, while the case for necessity modals can also be generalized in a similar way.

(12) German *irgendein*:

a. Assertion: $\Box \exists x[x \in D \wedge P(x)]$

b. Implicature: $\Box P(a) \to \Box P(b) \vee \Box P(c), \Box P(b) \to \Box P(a) \vee \Box P(c), \Box P(c) \to \Box P(a) \vee \Box P(b), \Box P(a) \vee \Box P(b) \to \Box P(c), \Box P(a) \vee \Box P(c) \to \Box P(b), \Box P(b) \vee \Box P(c) \to \Box P(a)$

c. Inference: $\forall x[x \in D \wedge \Diamond P(x)]$

(13) Spanish *algún*:

a. Assertion: $\Box \exists x[x \in D \wedge P(x)]$

b. Implicature: $\Box P(a) \to \Box P(b) \vee \Box P(c), \Box P(b) \to \Box P(a) \vee \Box P(c), \Box P(c) \to \Box P(a) \vee \Box P(b)$

c. Inference: $\exists x \exists y[x, y \in D \wedge x \neq y \wedge \Diamond P(x) \wedge \Diamond P(y)]$

2.1.3 SU

In order to account for the use of **SU** in a way parallel to the the treatment for EIs combined with an overt modal, Kratzer and Shimoyama (2002) propose to assume that assertions are implicitly modalized by a covert assertoric operator. Also following such an assumption, Alonso-Ovalle and Menéndez-Benito (2010) formalize the covert assertoric operator as in (14).

(14) $[\![\textsc{assert}]\!]^c = \lambda p.\lambda w.\forall w' \in \text{Epistemic}_{\text{speaker of } c}(w)[p(w')]$
(Alonso-Ovalle and Menéndez-Benito 2010)

Note that the assertoric operator defined in (14) is a necessity modal ranging over all the possible worlds in the speaker's epistemic state, and the ignorance inference can in this way still be taken as a result from the modal inference triggered by such an assertoric operator. However, as in the case of modals, the alternative based approach predicts different ignorance inferences for German *irgendein* and for Spanish *algún*, namely, total variation for *irgendein* and partial variation for *algún*. In addition, the assumption of a covert operator is not independently motivated. As will be later introduced in the thesis, both the conceptual cover approach by Aloni and Port (2010, 2015) and the team semantics approach by Aloni and Degano (2022, 2023) generate ignorance without this assumption.

2.1.4 Question

Both Alonso-Ovalle and Menéndez-Benito (2010) and Kratzer and Shimoyama (2002) do not discuss explicitly the dual function for EIs to be used as interrogative words licensing constituent questions. However, the interrogative use of Mandarin *shenme* can be formalized according to Kratzer and Shimoyama (2002) by allowing it to be associated with the question operator $[Q]$, which for simplicity could be defined as an identity function as in (15).[5]

[5]The following are two definitions by Kratzer and Shimoyama (2002) in the proposal.

(i) $[\![Q\alpha]\!]^{w,g} = [\![\alpha]\!]^{w,g}$

(ii) $[\![Q\alpha]\!]^{w,g} = \{\lambda w'.\forall p[p \in [\![\alpha]\!]^{w,g} \to [p(w) = 1 \leftrightarrow p(w') = 1]]\}$

(15) a. *shenme man*: $\{x : x \in D \wedge Man(x)\}$
b. $[Q]$(*shenme man walks*): $[Q](d_1$ is a man walking, d_2 is a man walking, d_3 is a man walking, ...$)$ $= \{d_1$ is a man walking, d_2 is a man walking, d_3 is a man walking, ...$\}$, where $d_1, d_2, d_3, \ldots \in [\![shenme\ man]\!]$.

2.2 Exhaustification based approach

The exhaustification based approach as proposed by Chierchia (2006, 2013), Chierchia and Liao (2015), Fox (2007), and Law (2019) is also a pragmatic account that derives the inferences of EIs as exhaustification based implicatures with respect to alternatives. Compared with the alternative based approach (Alonso-Ovalle and Menéndez-Benito 2010; Kratzer and Shimoyama 2002), the exhaustification based approach formalizes two classes of alternatives as propositions and in addition proposes an exhaustification operator to be conducted on them.

Note that the exhaustification based approach is also similar to the alternative based approach in its explanation for the uses of EIs, except for, however, its lacking an account of questions. Specifically, the exhaustification based approach captures **co-var** and **NPI**, but cannot satisfactorily account for **SU**, **epiU** and **deoFC** as it would wrongly predict a uniform behavior to be licensed for a particular EI in such contexts. However, as will be seen in the following sections, the exhaustification based approach seems to partly explain the form puzzle of *shenme* under modals, as discusses by Law (2019), which is the only existing account addressing the difference between bare and non-bare *shenme*.

2.2.1 Key ingredients

According to the exhaustification based approach, indefinites, not only EIs, generally activate alternatives that can be grouped into two major classes: scalar alternatives (henceforth SAs) and domain alternatives (henceforth DAs), with the set of them shown in (16).

(16) Semantic components of *a book*:
a. Basic meaning (BM): $\lambda P.\exists x[x \in D \wedge book(x) \wedge P(x)]$
b. Scalar alternatives (SA): $\{\lambda P.\forall x[[x \in D \wedge book(x)] \rightarrow P(x)]\}$
c. Domain alternatives (DA): $\{\lambda P.\exists x[x \in D' \wedge book(x) \wedge P(x)] : D' \subset D\}$

Chierchia (2013) formalizes the implicature to be generated by taking the two classes of alternatives through a phonologically null exhaustification operator, often abbreviated as $\mathbb{O}$. $\mathbb{O}_{DA \cup SA}(p)$ suggests the proposition p to be the only true member of the set of its alternatives $DA \cup SA$, and the other alternatives are true only if entailed by p.

(17) $\mathbb{O}_{DA \cup SA}(p) = p \wedge \forall q \in DA \cup SA[q \rightarrow p \subseteq q]$

Applying $\mathbb{O}$ to an unmodalized sentence (18-a), where the domain is taken to be the set of a, b, c, would result in a self-contradictory implicature, as in (18-d). The episodic use of EIs can only be explained in a similar way to the strategy adopted in the alternative based approach – namely, by assuming the sentence to be covertly modalized by a null assertoric necessity modal (Chierchia and Liao 2015).

(18) a. BM: $\exists x[x \in D \wedge P(x)]$
b. SA: $\{\forall x[x \in D \rightarrow P(x)]\}$
c. DA: $\{P(a), P(b), P(c), P(a) \vee P(b), P(a) \vee P(c), P(b) \vee P(c)\}$

d. Implicature: $\mathbb{O}_{DA \cup SA}(\exists x[x \in D \wedge P(x)]) = \exists x[x \in D \wedge P(x)] \wedge \neg\forall x[x \in D \wedge P(x)] \wedge \neg P(a) \wedge \neg P(b) \wedge \neg P(c) \wedge \neg[P(a) \vee P(b)] \wedge \neg[P(a) \vee P(c)] \wedge \neg[P(b) \vee P(c)] = \bot$

When embedded under modals – the EI inferences are derived without changes for both possibility and necessity modals – the DAs are argued by Fox (2007) to be "pre-exhaustified" by applying the exhaustification operator recursively to every DA to avoid the contradiction in (19). Rather than the set of alternatives as represented in (19-b) and (19-c), the implicature with respect to (19-a) is based on the union set of SA (19-b) and the pre-exhaustified DAs (20-a), which gives rise to the free choice effect as derived in (20-b). Notably, the intuitive idea for pre-exhaustification, or alternatively, recursive exhaustification as in Fox (2007), is to take DAs to be exhaustified when negating them leads to contradiction with BM. Conceptually, pre-exhaustification plays a similar role to that of the exhaustivity inferences in Kratzer and Shimoyama (2002), and the DAs without pre-exhaustification are in the alternative based approach those claims derived by restricting the quantificational domain.

(19) a. BM: $\Diamond\exists x[x \in D \wedge P(x)]$
b. SA: $\{\Diamond\forall x[x \in D \wedge P(x)]\}$
c. DA: $\{\Diamond P(a), \Diamond P(b), \Diamond P(c), \Diamond[P(a) \vee P(b)], \Diamond[P(a) \vee P(c)], \Diamond[P(b) \vee P(c)]\}$
d. Implicature: $\mathbb{O}_{DA \cup SA}(\Diamond\exists x[x \in D \wedge P(x)]) = \Diamond\exists x[x \in D \wedge P(x)] \wedge \neg\Diamond\forall x[x \in D \wedge P(x)] \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(b) \wedge \neg\Diamond P(c) \wedge \neg\Diamond[P(a) \vee P(b)] \wedge \neg\Diamond[P(a) \vee P(c)] \wedge \neg\Diamond[P(b) \vee P(c)] = \bot$

(20) a. Exh-DA: $\{\mathbb{O}\Diamond P(a), \mathbb{O}\Diamond P(b), \mathbb{O}\Diamond P(c), \mathbb{O}\Diamond[P(a) \vee P(b)], \mathbb{O}\Diamond[P(b) \vee P(b)], \mathbb{O}\Diamond[P(b) \vee P(c)]\}$
(i) $\mathbb{O}\Diamond P(a) = \Diamond P(a) \wedge \neg\Diamond P(b) \wedge \neg\Diamond P(c)$
(ii) $\mathbb{O}\Diamond P(b) = \Diamond P(b) \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(c)$
(iii) $\mathbb{O}\Diamond P(c) = \Diamond P(c) \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(b)$
(iv) $\mathbb{O}\Diamond[P(a) \vee P(b)] = \Diamond[P(a) \vee P(b)] \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(b) \wedge \neg\Diamond P(c)$
(v) $\mathbb{O}\Diamond[P(a) \vee P(c)] = \Diamond[P(a) \vee P(c)] \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(b) \wedge \neg\Diamond P(c)$
(vi) $\mathbb{O}\Diamond[P(b) \vee P(c)] = \Diamond[P(b) \vee P(c)] \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(b) \wedge \neg\Diamond P(c)$
b. Implicature: $\mathbb{O}_{Exh\text{-}DA \cup SA}(\Diamond\exists x[x \in D \wedge P(x)]) = \Diamond\exists x[x \in D \wedge P(x)] \wedge \neg\Diamond\forall x[x \in D \wedge P(x)] \wedge \neg\mathbb{O}\Diamond P(a) \wedge \neg\mathbb{O}\Diamond P(b) \wedge \neg\mathbb{O}\Diamond P(c) \wedge \neg\mathbb{O}\Diamond[P(a) \vee P(b)] \wedge \neg\mathbb{O}\Diamond[P(a) \vee P(c)] \wedge \neg\mathbb{O}\Diamond[P(b) \vee P(c)] = \forall x[x \in D \wedge \Diamond P(x)]$

In this way, the DAs derived in the exhaustification based approach still serve to avoid either a false claim or a false exhaustivity inference as proposed by Alonso-Ovalle and Menéndez-Benito (2010) and Kratzer and Shimoyama (2002). However, the exhaustification based approach in addition proposes a class of SA and computes the implicature in a uniform way by applying the exhaustification operator to the union of SA and DAs. Therefore, we can expect the analysis of EIs with respect to their scope behavior, modal inferences, and **NPI** readings using the exhaustification based approach to be conducted similarly as in the solution from the alternative based approach. Specifically, the exhaustification based approach still predicts the inferences of an EI under deontic modals to be the same as those under epistemic modals, and fails to account for the distinction between total variation under deontic modals and partial variation under epistemic modals as licensed by German *irgendein* and Mandarin *shenme*.

Both the pragmatic accounts based on alternatives and implicatures treat the modal inferences of either partial or total variation to be resulted from the generation of DAs. For example, we have seen from (20) that the DAs as defined in (16-c) eventually give rise to the free choice inference. In contrast, the implicature of partial variation (22) is derived if taking only the DAs in (21).

(21) a. Semantic components of *a book*
b. Domain alternatives (DA): $\{\lambda P.\exists x[x \in D' \wedge book(x) \wedge P(x)] : D' \subset D \wedge |D'| = 1\}$

(22) a. BM: $\Diamond\exists x[x \in D \wedge P(x)]$
b. SA: $\{\Diamond\forall x[x \in D \wedge P(x)]\}$
c. DA: $\{\Diamond P(a), \Diamond P(b), \Diamond P(c)\}$
d. Exh-DA: $\{\mathbb{O}\Diamond P(a), \mathbb{O}\Diamond P(b), \mathbb{O}\Diamond P(c)\}$
(i) $\mathbb{O}\Diamond P(a) = \Diamond P(a) \wedge \neg\Diamond P(b) \wedge \neg\Diamond P(c)$
(ii) $\mathbb{O}\Diamond P(b) = \Diamond P(b) \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(c)$
(iii) $\mathbb{O}\Diamond P(c) = \Diamond P(c) \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(b)$
e. Implicature: $\mathbb{O}_{Exh\text{-}DA \cup SA}(\Diamond\exists x[x \in D \wedge P(x)]) = \Diamond\exists x[x \in D \wedge P(x)] \wedge \neg\Diamond\forall x[x \in D \wedge P(x)] \wedge \neg\mathbb{O}\Diamond P(a) \wedge \neg\mathbb{O}\Diamond P(b) \wedge \neg\mathbb{O}\Diamond P(c) = \exists x\exists y[x, y \in D \wedge x \neq y \wedge \Diamond P(x) \wedge \Diamond P(y)]$

While Alonso-Ovalle and Menéndez-Benito (2010) and Kratzer and Shimoyama (2002) attribute the selection of DAs to some characteristic of an EI itself and predict a uniform behavior for such an EI under both deontic and epistemic modals, the other way proposed by Law (2019) is to take the distinction between modals as a point of departure. According to her, the DAs activated under deontic modals are essentially different from those under epistemic modals, with the former defined as in (16) and the latter as in (21). Her analysis, though without any motivation on the reason to treat deontic and epistemic modals differently, to some extent works out the form puzzle of the Mandarin EI *shenme* – non-bare *shenme* is more acceptable than bare *shenme* under deontic modals, while both forms are felicitous under epistemic modals.

2.2.2 Plurality

As motivated already in Chapter 1, one of the form puzzles for the Mandarin EI *shenme* is that bare *shenme* and non-bare *shenme* have slightly different distributions with respect to modality. Law (2019) summarizes the puzzle in the following configurational representation (23): while the numeral classifier may and may not occur with *shenme* under epistemic modals (23-a), embedding *shenme* in the scope of deontic modals however mandatorily requires the presence of a numeral classifier(23-b).

(23) a. Epistemic modal . . . (NUM CL) *shenme*
b. Deontic modal . . . *(NUM CL) *shenme*

Law (2019) extends the exhaustification based approach following the analysis of pluralities in Link (1983) and Schwarzschild (1996). Plural individuals are sums of atomic individuals or other plural individuals, with $\oplus$ taken as the sum formation operator. The domain of individuals thus consists of both atomic and plural individuals, and is closed under sum formation. To exemplify, the domain of three atomic individuals a, b, c is taken to have the following mereological structure.

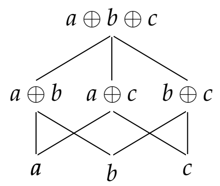


Figure 2.4: Plurality structure

Suppose henceforth that there are only two atomic individuals a, b in the domain D. Law (2019) assumes Mandarin nouns, which have no morphological marking for singularity and plurality, to be like English mass nouns as argued by Chierchia (1998, 2010).[6] For example, while English *book* and *books* are taken as two predicates having different denotations as in (24-a) and (24-b), the Mandarin noun *shu* 'book(s)' denotes in its extension a set of both atomic and plural books.

(24) a. $[\![\text{book}]\!] = \{a, b\}$
b. $[\![\text{books}]\!] = \{a \oplus b\}$
c. $[\![\text{shu}]\!]\text{'book(s)'} = \{a, b, a \oplus b\}$

To individuate Mandarin nouns to an appropriate counting level, a classifier is always required between a numeral and its modified nouns. The numeral classifier *yi ben* 'one CL' and its combination with the noun *shu* 'book(s)' are formalized by Law (2019) in (25) and (26) respectively. Note that ATOM is a function mapping an individual to its atomic parts, which will be later formalized in Chapter 3.

(25) $[\![\text{one CL}]\!] = \lambda D.\{x : x \in D \wedge |\text{ATOM}(x)| = 1\}$

(26) Semantic components of *one* CL *book*:
a. BM: $\lambda P.\exists x[x \in D \wedge book(x) \wedge |\text{ATOM}(x)| = 1 \wedge P(x)]$
b. SA: $\{\lambda P.\forall x[x \in D \wedge book(x) \wedge |\text{ATOM}(x)| = 1 \rightarrow P(x)]\}$
c. DA: $\{\lambda P.\exists x[x \in D' \wedge book(x) \wedge |\text{ATOM}(x)| = 1 \wedge P(x)] : D' \subset D\}$,
or, $\{\lambda P.\exists x[x \in D' \wedge book(x) \wedge |\text{ATOM}(x)| = 1 \wedge P(x)] : D' \subset D \wedge |D'| = 1\}$

Before moving on to compute the implicatures of bare and non-bare *shenme* under modals, it is worth noting that the proposition $P(a \oplus b)$ is truth-conditionally equivalent to the conjunction of $P(a)$ and $P(b)$ (where P is not a collective predicate), often taken as lexical distributivity.

(27) $P(a \oplus b) = P(a) \wedge P(b)$

2.2.3 Form distinction

The set of DAs licensed by deontic and epistemic modals in relation to bare *shenme* is repeated in (28).

(28) a. DA for deontic modals: $\{\lambda P.\exists x[x \in D' \wedge P(x)] : D' \subset D\}$
b. DA for epistemic modals: $\{\lambda P.\exists x[x \in D' \wedge P(x)] : D' \subset D \wedge |D'| = 1\}$

In the case of bare *shenme*, both atomic and plural individuals can be quantified. The sentence embedding bare *shenme* under possibility modals – either deontic or epistemic – is represented to have its BM and SA as in (29).

(29) a. BM: $\Diamond\exists x[x \in D \wedge P(x)] = \Diamond[P(a) \vee P(b) \vee P(a \oplus b)]$
b. SA: $\{\Diamond\forall x[x \in D \wedge P(x)]\} = \{\Diamond[P(a) \wedge P(b) \wedge P(a \oplus b)]\} = \{\Diamond P(a \oplus b)\}$

As required by deontic modals, the set of DAs for the bare *shenme* sentence is computed in (30-a), and the set of pre-exhaustified DAs in (30-b). The implicature drawn for bare *shenme* under deontic modals from the set of SA and pre-exhaustified DAs would, however, lead to contradiction with its BM, as underlined in (30-c).

(30) a. DA: $\{\Diamond\exists x[x \in D' \wedge P(x)] : D' \subset D\} = \{\Diamond P(a), \Diamond P(b), \Diamond P(a \oplus b), \Diamond[P(a) \vee P(b)]\}$

[6] For another analysis of Mandarin classifiers without assuming the nouns to be mass, see Appendix B.

b. Exh-DA: $\{\mathbb{O}\Diamond P(a), \mathbb{O}\Diamond P(b), \mathbb{O}\Diamond P(a \oplus b), \mathbb{O}\Diamond[P(a) \vee P(b)]\}$
   (i) $\mathbb{O}\Diamond P(a) = \Diamond P(a) \wedge \neg\Diamond P(b) \wedge \neg\Diamond P(a \oplus b)$
   (ii) $\mathbb{O}\Diamond P(b) = \Diamond P(b) \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(a \oplus b)$
   (iii) $\mathbb{O}\Diamond P(a \oplus b) = \Diamond P(a \oplus b)$
   (iv) $\mathbb{O}\Diamond[P(a) \vee P(b)] = \Diamond[P(a) \vee P(b)] \wedge \neg\Diamond P(a \oplus b)$

c. Implicature: $\underline{\Diamond[P(a) \vee P(b) \vee P(a \oplus b)]} \wedge \underline{\neg\Diamond P(a \oplus b)} \wedge \Diamond P(a) \rightarrow [\Diamond P(b) \vee \Diamond P(a \oplus b)] \wedge \Diamond P(b) \rightarrow [\Diamond P(a) \vee \Diamond P(a \oplus b)] \wedge \underline{\Diamond[P(a) \vee P(b)] \rightarrow \Diamond P(a \oplus b)}$

In contrast, embedding bare *shenme* under epistemic modals would not result in a self-contradictory implicature. The reason is that the DAs activated by epistemic modals (31-a) are essentially different from those by deontic modals in the proposal by Law (2019). Exhaustifying bare *shenme* under epistemic modals in relation to the set of SA and pre-exhaustified DAs (31-b) results in no contradiction but rather partial variation (31-c).

(31) a. DA: $\{\Diamond\exists x[x \in D' \wedge P(x)] : D' \subset D \wedge |D'| = 1\} = \{\Diamond P(a), \Diamond P(b), \Diamond P(a \oplus b)\}$

b. Exh-DA: $\{\mathbb{O}\Diamond P(a), \mathbb{O}\Diamond P(b), \mathbb{O}\Diamond P(a \oplus b)\}$
   (i) $\mathbb{O}\Diamond P(a) = \Diamond P(a) \wedge \neg\Diamond P(b) \wedge \neg\Diamond P(a \oplus b)$
   (ii) $\mathbb{O}\Diamond P(b) = \Diamond P(b) \wedge \neg\Diamond P(a) \wedge \neg\Diamond P(a \oplus b)$
   (iii) $\mathbb{O}\Diamond P(a \oplus b) = \Diamond P(a \oplus b)$

c. Implicature: $\Diamond[P(a) \vee P(b) \vee P(a \oplus b)] \wedge \neg\Diamond P(a \oplus b) \wedge \Diamond P(a) \rightarrow [\Diamond P(b) \vee \Diamond P(a \oplus b)] \wedge \Diamond P(b) \rightarrow [\Diamond P(a) \vee \Diamond P(a \oplus b)] = \Diamond[P(a) \vee P(b)] \wedge \Diamond P(a) \leftrightarrow \Diamond P(b)$

As for non-bare *shenme*, only the individuals with atoms in accordance with the numeral can be quantified from the domain. For example, the modal sentence with the numeral classifier 'one CL' has its BM and SA as represented in (32).

(32) a. BM: $\Diamond\exists x[x \in D \wedge P(x) \wedge |\textsc{atom}(x)| = 1] = \Diamond[P(a) \vee P(b)]$

b. SA: $\{\Diamond\forall x[x \in D \wedge P(x) \wedge |\textsc{atom}(x)| = 1] = \Diamond[P(a) \wedge P(b)]\}$

With the numeral classifier 'one CL' added on, the Mandarin noun behaves like English singular count nouns. The implicatures drawn from both deontic and epistemic modals do not result in contradiction, as derived in (33) and (34) respectively.

(33) a. DA: $\{\Diamond\exists x[x \in D' \wedge P(x) \wedge |\textsc{atom}(x)| = 1] : D' \subset D\} = \{\Diamond P(a), \Diamond P(b), \Diamond[P(a) \vee P(b)]\}$

b. Exh-DA: $\{\mathbb{O}\Diamond P(a), \mathbb{O}\Diamond P(b), \mathbb{O}\Diamond[P(a) \vee P(b)]\}$
   (i) $\mathbb{O}\Diamond P(a) = \Diamond P(a) \wedge \neg\Diamond P(b)$
   (ii) $\mathbb{O}\Diamond P(b) = \Diamond P(b) \wedge \neg\Diamond P(a)$
   (iii) $\mathbb{O}\Diamond[P(a) \vee P(b)] = \Diamond[P(a) \vee P(b)]$

c. Implicature: $\Diamond[P(a) \vee P(b)] \wedge \neg\Diamond[P(a) \wedge P(b)] \wedge \Diamond P(a) \leftrightarrow \Diamond P(b)$

(34) a. DA: $\{\Diamond\exists x[x \in D' \wedge P(x) \wedge |\textsc{atom}(x)| = 1] : D' \subset D \wedge |D'| = 1\} = \{\Diamond P(a), \Diamond P(b)\}$

b. Exh-DA: $\{\mathbb{O}\Diamond P(a), \mathbb{O}\Diamond P(b)\}$
   (i) $\mathbb{O}\Diamond P(a) = \Diamond P(a) \wedge \neg\Diamond P(b)$
   (ii) $\mathbb{O}\Diamond P(b) = \Diamond P(b) \wedge \neg\Diamond P(a)$

c. Implicature: $\Diamond[P(a) \vee P(b)] \wedge \neg\Diamond[P(a) \wedge P(b)] \wedge \Diamond P(a) \leftrightarrow \Diamond P(b)$

The analysis by Law (2019) seems to capture the basic facts about the interaction of *shenme* with modalities, but it is worth noting that her analysis relies on an ad hoc assumption linking different set of alternatives to different modality in a way that is not explanatory. Later in Chapter 4 of the thesis, I will however discuss another example where bare *shenme* is judged felicitous under deontic modals, and therefore challenge the analysis by Law (2019).

2.3 Conceptual cover approach

In addition to the two aforementioned pragmatic accounts, Aloni and Port (2010, 2015) propose the conceptual cover approach that aims to derive all the behaviors of EIs from their own semantics without appealing to alternatives and implicatures. They take the ignorance inference of EIs as a result from the speaker's failure to identify the referent according to a particular method of identification, or in their words, according to a particular conceptual cover.

To illustrate, consider the following context for the sentence (35). As the cards can be identified either by their position or by their suit, the truth of (35) is however dependent on which identification method is eventually adopted in evaluation. Namely, (35) is true with respect to the suit of cards, but false if evaluated from the perspective of their position.

(35) *Context: In front of you lie two face-down cards, one is the Ace of Hearts, the other is the Ace of Spades. You know that the winning card is the Ace of Hearts, but you don't know whether it's the card on the left or the one on the right.*
You know which card is the winning card.

Following such an idea to evaluate the truth of a sentence with respect to the method of identification, Aloni (2001) formalizes the notion of conceptual covers as in (36), where a conceptual cover is taken as a set of individual concepts that exclusively and exhaustively covers the domain of individuals.

(36) Conceptual covers:
Given a set of possible worlds W and a domain of individuals D, a *conceptual cover* CC based on (W, D) is a set of functions $W \to D$ such that:
$\forall w \in W : \forall d \in D : \exists! c \in CC : c(w) = d$

The conceptual covers for (35) can be taken as in (37), where the cards can be identified by ostension (37-a), by naming (37-b), and by description (37-c) respectively. (37-d) however cannot be taken as an example for a conceptual cover, as the Ace of Spades can be in some possible world the card on the left.

(37) a. {on-the-left, on-the-right} [ostension]
b. {ace-of-spades, ace-of-hearts} [naming]
c. {the-winning-card, the-losing-card} [description]
d. #{one-the-left, ace-of-spades}

According to the semantics for knowing-*wh* constructions in Aloni (2001), the evaluation of (38) requires to specify a particular conceptual cover such that the *wh*-phrase is taken to range over concepts in the conceptual cover rather than over plain individuals.

(38) You know which$_n$ card is the winning card.
a. False, if $n \mapsto$ {on-the-left, on-the-right}
b. True, if $n \mapsto$ {ace-of-spades, ace-of-hearts}
c. Trivial, if $n \mapsto$ {the-winning-card, the-losing-card}

The puzzle of EIs is analyzed in the conceptual cover approach on the basis that there are at least two conceptual covers concerned. To illustrate, in (39), the speaker can identify the referent of *irgendein* in some conceptual cover as the German EI is used specifically – for example, she knows that the student who called called. However in the meanwhile, she cannot identify the referent in another conceptual cover as required by the ignorance inference. Aloni and Port (2010, 2015) base their proposal on the intuition that the referents of EIs are typically identified by a method different from the one contextually required for knowledge. They formalize such an intuition in terms of conceptual cover shift (henceforth CC-shift), by which the contextually supplied conceptual cover fails in identification and is shifted to another one for the speaker to identify the referent.

(39) *Irgendein* Student hat angerufen.
Some student has called
'Some student called (and I don't know who).'

2.3.1 Key ingredients

The conceptual cover approach (Aloni and Port 2010, 2015) treats EIs as in Dynamic Semantics, and proposes additionally two classes of domain shift that EIs may associate with.

The first class of domain shift is CC-shift, which requires the referent of an EI to be shifted into a certain conceptual cover so that the speaker can identify it. The reason for CC-shift is related to the conventionalized ignorance effect of the EI – only when the referent cannot be identified by the conceptual cover contextually required for knowledge should the speaker resort to another one for identification. Therefore, CC-shift is generally allowed for by EIs.

The other class of domain shift is domain widening (henceforth DW), which is conceptually similar to treating EIs as domain wideners in the pragmatic accounts. DW is taken to explain behaviors of EIs other than the ignorance effect, and is only induced by some but not all of EIs.

Focusing mainly on the German EI *irgendein* and the Italian EI *un qualche*, Aloni and Port (2010, 2015) explain the distinction between the two EIs by assuming that *irgendein* allows for both CC-shift and DW, whereas *un qualche* only allows for CC-shift.

In their account, EIs are taken to induce an obligatory domain shift, and they are felicitous in a context σ iff the domain shift that they induce is for a reason, as shown in (40).

(40) Felicity condition for domain shift $D \rightarrow D'$ in the context σ:
   a. CC-shift is justified only if otherwise the speaker state would not have supported the statement:
      $\sigma \vDash \ldots \exists x_{D'} \ldots$, but $\sigma \nvDash \ldots \exists x_D$
   b. DW is justified only if it creates a stronger statement:
      $\ldots \exists x_{D'} \ldots \vDash \ldots \exists x_D \ldots$

Notably, the felicity condition is defined in terms of support, whereas Aloni and Port (2010, 2015) also in their account distinguish between the notions of support and truth. A state σ *supports* ϕ, $\sigma \vDash \phi$ iff all possibilities in σ survive simultaneously in one and the same output state. A sentence ϕ is *true* in a state σ, $\sigma \vdash \phi$ iff each possibility in σ survives in at least one of the states resulting from updating σ with ϕ.

The conceptual cover approach reasons about the behaviors of EIs through the following facts concerning CC-shift in (41) and DW in (42). Specifically, while the conceptual cover approach correctly predicts the use of **SU**, **epiU**, **NPI**, and **deoFC** with a revised solution as in Aloni (2012), Aloni and Franke (2013), and Aloni and Port (2015), it cannot capture the scope behavior of EIs when combined with a universal quantifier and in addition fails to account for possible question uses of EIs, as will be discussed in the next sections.

(41) CC-shift, when justified, would license partial variation;
   a. CC-shift can be justified in specific uses and under epistemic modals;
   b. CC-shift is never justified under negation and under deontic modals.

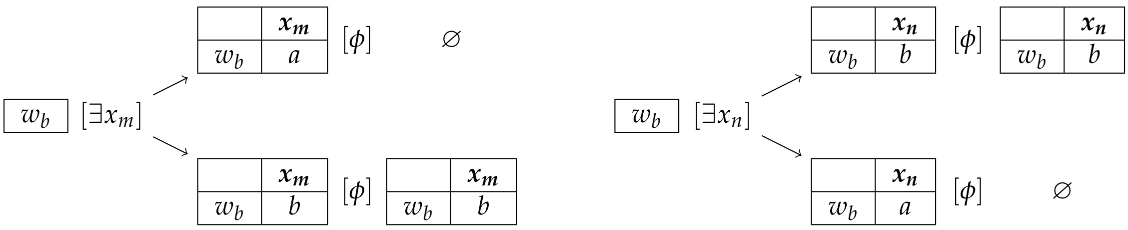
(42) DW is justified only if it creates a stronger statement;

a. DW is justified under negation;
b. DW is not justified in specific uses and under epistemic modals.

2.3.2 SU

According to the conceptual cover approach, the **SU** use of EIs is resulted directly from CC-shift in combination with its felicity condition.

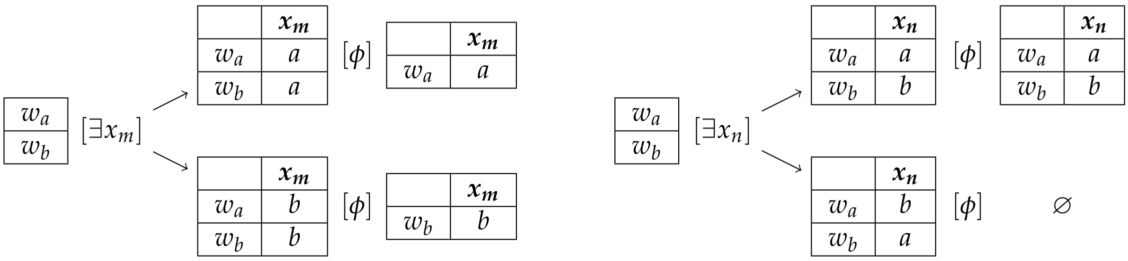
Figure 2.5 and Figure 2.6 show two CC-shifts in the setting of Dynamic Semantics with the former justified and the latter unjustified, where $D = \{a, b\}$ and w_x is a possible world with only x satisfying ϕ. Suppose that the rigid conceptual cover m is contextually required for knowledge. In Figure 2.5 where the state is of total information, the existential sentence is supported regardless of the identification method to be adopted, and the CC-shift from m to n is not justified. It can be easily seen that DW is also not justified in specific uses, and the conceptual cover approach correctly predicts the infelicity of EIs in a context of total information.



(a) $\exists x_m \phi$ true and supported

(b) $\exists x_n \phi$ true and supported

Figure 2.5: An unjustified CC-shift



(a) $\exists x_m \phi$ true but not supported

(b) $\exists x_n \phi$ true and supported

Figure 2.6: A justified CC-shift from m to n

Intuitively, an existential sentence $\exists x_{cc} \phi$ under the conceptual cover cc is supported in a state σ only if in σ the witness of the existential sentence under cc can be identified. In Figure 2.6, while the relevant referent cannot be identified under m – thus the ignorance inference – shifting m to n would make it possible for the referent to be identified. Therefore, the CC-shift is justified, and EIs are taken to be felicitous in such contexts.

In addition, Aloni and Port (2010, 2015) argue that the modal variation obtained by CC-shift is partial variation. The reason is that CC-shift, when justified, would require the new conceptual cover n to essentially differ from the contextually supplied one m, as in (43). In addition, an ignorance inference arises as the speaker fails to identify the referent of the EI, as shown by (44). Therefore, the following sentence (44) is taken to be true and gives rise to partial variation.

(43) a. Maria married *un qualche/irgendein* professor.
b. $\exists x_n \phi(x_n)$ $[n \neq m]$

(44) a. The speaker does not know who Maria married.
b. $\neg\exists y_m \Box_e \phi(y_m)$[7]

(45) $\exists x_n \phi(x_n) \vDash \neg\exists y_m \Box_e \phi(y_m)$

(Aloni and Port 2010)

2.3.3 co-var

However, as pointed out by Alonso-Ovalle and Menéndez-Benito (2017), the conceptual cover approach fails to predict the **co-var** use of EIs when combined with a universal quantifier. Specifically, EIs are predicted to be felicitous for the wide scope reading as CC-shift is justified, while the narrow scope reading would however result in the unjustification of CC-shift and hence the infelicity of EIs.

Consider Figure 2.7 and Figure 2.8 where $D = \{a, b\}$, and w_{x_1,x_2} is a possible world with only (x_1, p) and (x_2, q) satisfying ϕ, with p and q to be quantified over by the universal quantifier. Figure 2.7 starts with a state of two worlds $\{w_{a,a}, w_{b,b}\}$, which is essentially compatible with the wide scope reading, for example, that there is a specific book bought by all the students. The ignorance inference that the speaker does not know which book can be attributed to the failure for $\exists x_m \forall y \phi$ to be supported in the contextually supplied conceptual cover m. As $\exists x_m \forall y \phi$ is supported in the shifted conceptual cover n, such a CC-shift is justified and the use for EIs in the wide scope reading is rendered felicitous.

However, when it comes to the narrow scope reading that there are at least two different books being bought, the state $\{w_{a,b}\}$ is found to always support $\forall y \exists x_{cc} \phi$ no matter the conceptual cover cc is taken to be either m or n as in Figure 2.8. In this way, the CC-shift from m to n is not justified, and EIs are incorrectly predicted to be infelicitous in the narrow scope reading.

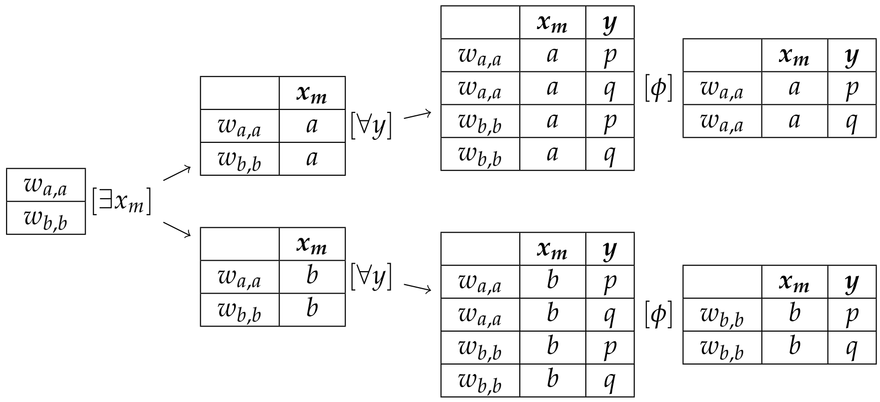
2.3.4 Modal

As shown by Figure 2.9 and Figure 2.10, CC-shift can be justified under epistemic modals $\Box_e$, but not under deontic modals $\Box_d$.[8] The reason is that Aloni and Port (2010, 2015) endorse a different analysis for the two classes of modality: epistemic modals are defined in terms of support, whereas deontic modals are defined in terms of truth. Conceptually, their definition for epistemic modals is similar to that in Dynamic Semantics (Veltman 1996) in that epistemic modals are taken as non-eliminative updates testing on whether the current information state supports or is compatible with some piece of further information. Deontic modals, in contrast, are not required to quantify over the current information state and are defined in terms of classical truth.

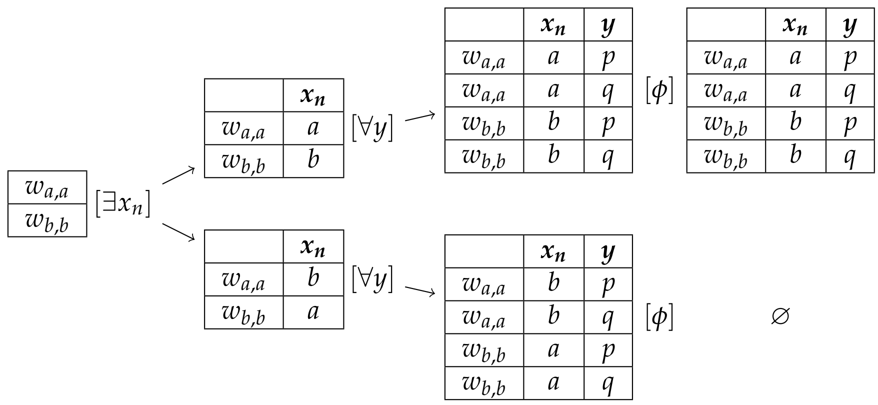
With epistemic and deontic modality analyzed in this way, the conceptual cover approach in Aloni and Port (2010, 2015) predicts the use of **epiU** for EIs as they trigger CC-shift, and the **deoFC** use for EIs allowing for also DW. Notably, the free choice inferences under deontic modals are derived as implicatures using the game-theoretical approach of Franke (2011), which

[7] $\Box_e$ stands for epistemic necessity modals.

[8] Note that by $\Box_e$ and $\Box_d$, Aloni and Port (2010, 2015) denote epistemic and deontic necessity modals respectively. The following analysis of epistemic/deontic modality however holds for both possibility and necessity modals. Specifically, the state updated should not be empty for possibility modals, while it must coincide with the original state in the case of necessity modals.



(a) $\exists x_m \forall y \phi$ not supported



(b) $\exists x_n \forall y \phi$ supported

Figure 2.7: A justified CC-shift from m to n for wide scope reading

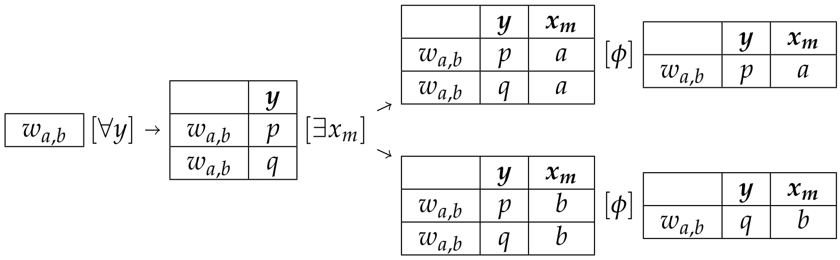
can be easily integrated into the dynamic approach of Aloni and Port (2010, 2015) (see Aloni and Franke (2013) for details). These free choice implicatures become obligatory for DW indefinites because of the strengthening requirement of DW.

To illustrate, it can be seen from Figure 2.9 that $\Box_e \exists x_{cc} \phi$ is evaluated with respect to the support of $\exists x_{cc} \phi$ in Figure 2.6, and from Figure 2.10 $\Box_d \exists x_{cc} \phi$ with respect to the truth of $\exists x_{cc} \phi$ in Figure 2.6. The CC-shift from m to n is justified for $\Box_e \exists x_{cc} \phi$, and EIs are taken to be felicitous in the scope of epistemic modals to license partial variation. In contrast, $\Box_d \exists x_{cc} \phi$ is supported in both m and n, which makes CC-shift trivialized.[9] As DW ($D \rightarrow D'$) is also not justified as in (46-a), the conceptual cover approach in Aloni and Port (2010) incorrectly predicts the infelicity

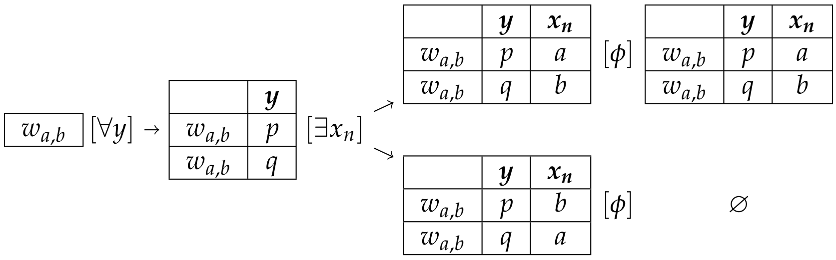
[9]Truth is taken by Aloni (2001) as a notion being not CC-sensitive. This can be seen from the classical interpretation that the existential sentence is true if and only if there is such an individual satisfying the sentence, regardless of what conceptual cover is taken. Therefore, it follows that deontic modality defined in terms of truth is also not CC-sensitive, as in (i).

(i) $\forall m, n : \Box_d \exists x_m \phi \equiv \Box_d \exists x_n \phi$

As the readers may wonder under what circumstances is the sentence with deontic modality not true and not supported, the following figure gives an example.



(a) $\forall y \exists x_m \phi$ supported

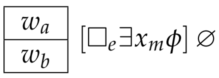


(b) $\forall y \exists x_n \phi$ supported

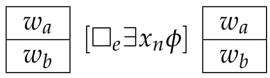
Figure 2.8: An unjustified CC-shift for narrow scope reading

of EIs under deontic modals. The solution from Aloni and Port (2015) is to incorporate also the universal free choice inference as in (46-b), and DW is therefore justified to license total variation under deontic modals.[10]

(46) a. $\Box \exists x_D \phi \vDash \Box \exists x_{D'} \phi$
b. $\Box \exists x_D \phi \wedge \forall x \Diamond \phi \nvDash \Box \exists x_{D'} \phi \wedge \forall x_{D'} \Diamond \phi$



(a) $\Box_e \exists x_m \phi$ not supported

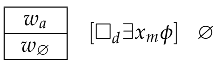


(b) $\Box_e \exists x_n \phi$ supported

Figure 2.9: A justified CC-shift from *m* to *n*

2.3.5 Negation

As for negation, CC-shift is trivialized as in (47-a), and the conceptual cover approach correctly predicts the infelicity of Italian *un qualche* in negative contexts, and in addition renders all the EIs



[10]Note that the felicity condition for DW is changed to (i) as in Aloni (2012).

(i) DW ($D \rightarrow D'$) is justified only if it doesn't create a weaker statement:
$\ldots \exists x_D \ldots \nvDash \ldots \exists x_{D'} \ldots$

(a) $\Box_d \exists x_m \phi$ supported

(b) $\Box_d \exists x_n \phi$ supported

Figure 2.10: An unjustified CC-shift from m to n

allowing for only CC-shift to be infelicitous under negation. The **NPI** use of German *irgendein* is explained by DW being justified under negation (47-b), and the conceptual cover approach predicts only the EIs compatible with DW to be licensed in negative contexts and to trigger the use of **NPI**.

(47) Negation:

a. Trivialization of CC-shift: $\forall m, n : \neg\exists x_m \phi \equiv \neg\exists x_n \phi$

b. DW $(D \rightarrow D')$: $\neg\exists x_{D'} \phi \vDash \neg\exists x_D \phi$

2.4 Summary

This chapter introduces three representative approaches to EIs, which can be summarized by Table 2.1. Both the alternative based approach and the exhaustification based approach predict a uniform behavior for EIs under modals, and following their assumption, also in episodic contexts where a covert necessity modal is assumed. Specifically, they fail to account for the distinction between partial variation in episodic contexts and under epistemic modals, and total variation under deontic modals. The conceptual cover approach, in contrast, cannot account for the narrow scope reading for EIs when combined with a universal quantifier in **co-var**. Note that both the exhaustification based approach and the conceptual cover approach do not have an account of question uses of *wh*-indefinites.

	SU	co-var	modal	NPI	plurality	Q
Alternative based approach	#	✓	✓✗	✓	#	✓
Exhaustification based approach	#	✓	✓✗	✓	✓	#
Conceptual cover approach	✓	#	✓	✓	#	#

Table 2.1: Summary

It is worth noting that all the three approaches are to some extent EI-specific. For example, both pragmatic accounts based on alternatives and implicatures predict the disappearance of modal inferences of EIs under negation, which naturally gives rise to the **NPI** reading. EIs not compatible with the function of **NPI** such as Italian *un qualche*, however, fail to be captured by these approaches. In contrast, the approaches requiring a semantic distinction between epistemic and deontic modals, as in Aloni and Port (2010, 2015) and Law (2019), may have problems with the Spanish EI *algún*, which exhibits a uniform behavior under both classes of modality.

As for the Mandarin EI *shenme*, the key observation is that it behaves differently under epistemic and deontic modals, and in addition does not necessarily license the **NPI** function as in the form of non-bare *shenme*. Table 2.2 points out the problems for the aforementioned approaches in capturing Mandarin *shenme*. Specifically, the alternative based approach (depicted in red) and the exhaustification based approach (depicted in green) cannot capture its distinction with respect to modal inference, the infelicity of **NPI** use for non-bare *shenme*, and in addition the exhaustification based approach lacks an analysis for the interrogative use of *shenme*. As for the conceptual cover approach (depicted in blue), how the question meaning of *shenme* is derived also needs to be accounted for, as well as the different behaviors of bare and non-bare *shenme* in negative and deontic modal contexts. This is beside its own problems when treating **co-var**.

The analysis that I will propose in the thesis is from the framework of team semantics by Aloni and Degano (2022, 2023) using tools from team logics and dependence logic. In Chapter 3, I will introduce the team semantics framework and propose to treat *shenme* as an existential triggering a variation atom together with a maximality requirement.

		↓↓	↓↓↓	↓↓↓	↓	↓↓
	SU	epiU	NPI	deoFC	co-var	Q
Bare *shenme*	✓	✓	✓	#	✓	✓
Non-bare *shenme*	✓	✓	#	✓	✓	✓

Table 2.2: How *shenme* can be captured

Chapter 3

Proposal

In Chapter 2, three representative approaches are reviewed with respect to their explanation for the behaviors of EIs. The alternative based approach (Alonso-Ovalle and Menéndez-Benito 2010; Kratzer and Shimoyama 2002) and the exhaustification based approach (Chierchia 2006, 2013; Chierchia and Liao 2015; Fox 2007; Law 2019) treat the ignorance of EIs to be derived as a certain implicature, and account for the behaviors of EIs in terms of modal inferences that require either an overt or a covert modal to be licensed. The conceptual cover approach (Aloni and Port 2010, 2015), in contrast, takes a semantic view and analyzes the ignorance of EIs as a result from a compulsory shift of conceptual cover to be licensed under the felicity condition, and the other uses of EIs are derived through different kinds of domain shift that they can possibly induce.

This chapter will introduce another semantic account for the puzzle of EIs, namely, the team semantics approach by Aloni and Degano (2022, 2023) (henceforth A&D). Their framework is established on the idea of Farkas and Brasoveanu (2020) that the notions of scopal and epistemic specificity are related to the contrast between stability and variability in value assignments for the variable introduced by an indefinite. Specifically, A&D define dependence and variation atoms with respect to value assignments of variables[1], and EIs are treated as existentials with a variation atom encoded in their semantics, which gives rise to a compulsory variation between the values of the variable given by different assignments and hence induces the ignorance inference.

Using the team semantics approach, I will firstly extend the A&D framework with an account of plurals to capture the difference between bare and non-bare *shenme*. In addition, I will argue that the Mandarin EI *shenme* can be formalized to have in its semantics a variation atom together with a maximality requirement for the value of the variable to be maximally assigned.

3.1 Team semantics approach

Most of the aforementioned approaches[2] treat EIs as existentials, but they differ in how the values of the existentially quantified variable can be assigned to induce the ignorance inference. Specifically, the values assigned to the variable are taken in both the alternative based approach

[1] (Galliani 2012, 2021; Hodges 1997; Väänänen 2007a,b).

[2] Kratzer and Shimoyama (2002) take the semantic representation of EIs to be a widened set of all the relevant individuals, which is further closed by an existential operator [∃].

(Alonso-Ovalle and Menéndez-Benito 2010) and the exhaustification based approach (Chierchia 2006, 2013; Chierchia and Liao 2015; Fox 2007; Law 2019) to range over individuals in the domain. The conceptual cover approach (Aloni and Port 2010, 2015) however takes the values of the variable to range over concepts in a certain conceptual cover.

Also analyzing indefinites in terms of existentials, Farkas and Brasoveanu (2020) take the value assignments for the variable as a point of departure in analyzing scopal and epistemic specificity[3], and they propose to treat specificity in terms of stability and non-specificity in terms of variability across different value assignments of the variable introduced by an indefinite.

(1) Scopal specificity:
  a. Every student read an article.
  b. Wide scope: There is one article such that every student read it.
  c. Narrow scope: For every student, there is one article such that she read it.

(2) Epistemic specificity:
  a. A student cheated on the exam.
  b. Known: The speaker knows which specific student cheated on the exam.
  c. Unknown: The speaker does not know which specific student cheated on the exam.

A&D follow Farkas and Brasoveanu (2020) and reserve the term specificity for scopal specificity, but use known and unknown for the epistemic distinction. For example in (3), they identify specific known (henceforth SK), specific unknown (henceforth SU), and non-specific (henceforth NS) readings. In addition, they formalize the proposal by Farkas and Brasoveanu (2020) to treat (non-)specificity in terms of stability and variability of value assignments in the framework of team semantics. Roughly, they construe value assignments to form a *set* that they refer to as a *team*, and define *dependence atom* and *variation atom* in their language to express notions of stability and variability for the values of the variable given by different assignments. EIs, in this way, can be standardly treated in their framework as strict existentials with a variation atom $var(\varnothing, x)$.

(3) Ali wants to buy a mug.
  a. Specific known (SK): There is a specific mug which Ali wants to buy, and the speaker knows which mug.
  b. Specific unknown (SU): There is a specific mug which Ali wants to buy, and the speaker does not know which mug.
  c. Non-specific (NS): Ali wants to buy a mug, and any mug would do.

In what follows, I will only briefly introduce the two-sorted team semantics framework defined in A&D before moving on to discuss how the Mandarin EI *shenme* can be formalized in the team semantics approach. For a full list of definitions, see Appendix C.

3.2 Key ingredients

A&D work with a two-sorted first-order team semantics framework, where the two sorts of entities are individuals in D and possible worlds in W. A team is a set of assignments that map variables to elements in the domain according to their sort. Initial teams are teams whose domain consists of only the designated variable for the actual world v receiving its value from W, in

[3] In addition, Farkas and Brasoveanu (2020) also discuss partitive specificity as another type of specificity, concerning whether or not the referent of an indefinite is a subset of a familiar set of entities.

order for them to represent factual information by showing which world is considered epistemically possible in the initial teams. Note that a team is a set of assignments where the variables may receive the same or different values across assignments. Specificity is captured by the value of the variable being constant for a fixed value for v. Epistemic specificity (known) is taken as a stricter notion than specificity, which requires the value of the variable to be constant across all the assignments. Teams can be regarded as information states of the speaker. Initial teams consist of epistemic possibilities that the speaker entertains from only the factual information, while discourse information is added by assignment extensions to the initial teams.

To illustrate, consider the team from Figure 3.1 where the initial team is depicted in blue. The variables w, x, and y are introduced to the initial team from discourse information through operations of assignment extension. While both x and y are specific as the value that they receive is constant given a fixed value for v, only x is epistemically known to the speaker as x remains constant across all the assignments.

v	w	x	y
v_1	w_1	a	b_1
v_2	w_2	a	b_2
...	...	a	...
v_n	w_n	a	b_n

Figure 3.1: Team as information states

As for how discourse information can be added to the teams by assignment extensions, A&D define three operations of universal extension, strict functional extension, and lax functional extension. Universal extension extends every assignment in the original team to all possible values with respect to a certain variable. Strict functional extension extends every assignment to only one value, while lax functional extension allows more than one values to be extended for every assignment.

For example, Aloni and Degano (2022) exemplify the three assignment extensions by Figure 3.2. Specifically, Figure 3.1b is the unique universal extension, Figure 3.1c is one of the four possible strict functional extensions, and Figure 3.1d is one of the nine lax functional extensions, based on the initial team in Figure 3.1a and with a domain of two individuals.

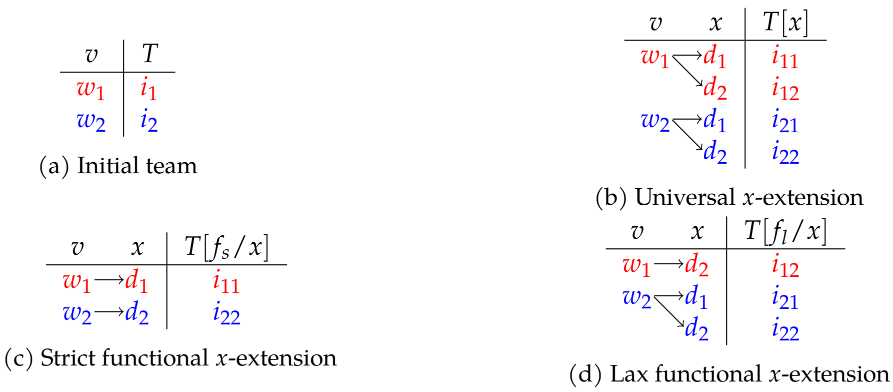


Figure 3.2: Assignment extension with $D = \{d_1, d_2\}$ from Aloni and Degano (2022)

To capture the proposal by Farkas and Brasoveanu (2020) on stability and variability of value assignments, A&D define the following notions of dependence and variation atoms. Intuitively, the value of y is dependent on the value of $\vec{x}$ iff any assignments agree on the value of $\vec{x}$ also agree on the value of y. The value of y varies from the value of $\vec{x}$ iff the dependence relation for the value of y on the value of $\vec{x}$ fails, namely, there are at least a pair of assignments agreeing on the value of $\vec{x}$ while not agreeing on the value of y.

Definition 3.2.1 (Dependence Atom).
$M, T \vDash dep(\vec{x}, y) \Leftrightarrow$ *for all* $i, j \in T : i(\vec{x}) = j(\vec{x}) \Rightarrow i(y) = j(y)$[4]

Definition 3.2.2 (Variation Atom).
$M, T \vDash var(\vec{x}, y) \Leftrightarrow$ *there is* $i, j \in T : i(\vec{x}) = j(\vec{x})\ \&\ i(y) \neq j(y)$

With the framework defined in this way, I am now able to capture indefinites and in addition the distinction among SK, SU, and NS readings.

Note that indefinites can refer to only one individual in the domain at a time, and are therefore modelled as existentials with strict extension, namely, strict existentials ($\exists_s x\phi$) in A&D. EIs are treated in the team semantics approach as strict existentials with a variation atom $var(\varnothing, x)$, which requires at least a pair of variation between the values assigned to the variable x, and therefore gives rise to the ignorance inference when used in episodic sentences.

(4) EI: $\exists_s x[\phi(x, v) \wedge var(\varnothing, x)]$

Building on Farkas and Brasoveanu (2020), the A&D framework allows the interpretation of indefinites to be *in-situ*, and their scope is modelled by dependence atoms where the variable of indefinites can co-vary with all the variables in the syntactic scope of the indefinites.

(5) Scopal specificity: Every student$_x$ read every article$_y$ that a professor$_z$ wrote.
   a. Wide scope: $\forall x \forall y \exists_s z[\phi \wedge dep(v, z)]$
   b. Intermediate scope: $\forall x \forall y \exists_s z[\phi \wedge dep(vx, z)]$
   c. Narrow scope: $\forall x \forall y \exists_s z[\phi \wedge dep(vxy, z)]$

Similarly, epistemic (non-)specificity (known vs. unknown) can also be captured in the A&D framework using dependence and variation atoms. SK reading is derived if the variable of the indefinite remains constant across all the assignments. As for SU reading, the value of the variable is dependent on which possible world is taken, but also varies for at least a pair of assignments to show the speaker's ignorance. NS reading is a result from the failure in specificity, and requires variation between values of the variable in even the same possible world.

(6) a. SK: $\exists_s x[\phi(x, v) \wedge dep(\varnothing, x)]$
   b. SU: $\exists_s x[\phi(x, v) \wedge dep(v, x) \wedge var(\varnothing, x)]$
   c. NS: $\exists_s x[\phi(x, v) \wedge var(v, x)]$

3.3 Plurality

From this section on, I will discuss how the Mandarin EI *shenme* can be captured using the team semantics approach. To begin with, in order to capture the form distinction between bare *shenme* and non-bare *shenme*, the A&D framework should be extended with plurality by allowing also plural individuals in the domain.

Definition 3.3.1 (Pluralized Domain). *Given a domain of individuals D, the pluralized domain generated by D is the join semi-lattice $(\uparrow D, \oplus)$ isomorphic to $(\mathcal{P}(D) \setminus \{\varnothing\}, \cup)$ with $D \subseteq \uparrow D$ as set of atoms, where $\oplus$ is the idempotent, commutative and associative binary operation of summation.*

[4]In A&D, $\vec{x}$ stands for an arbitrary sequence $x_1, \ldots, x_n$.

In terms of $\oplus$, I can further define a binary relation $\leq$ for elements in $\uparrow D$ as follows: for all $x, y \in \uparrow D$, $x \leq y$ if and only if $x \oplus y = y$. Then the sum of x and y, in symbols $x \oplus y$, is the smallest entity in $\uparrow D$ which has x and y as its parts.

As I follow Chierchia (1998, 2010) and Law (2019) to treat Mandarin nouns to be like English mass nouns and numeral classifiers to individuate such nouns in terms of atoms, the following function is defined to atomize individuals in the pluralized domain by returning a set of their atoms.

For each individual $d \in \uparrow D$, I denote by $\textsc{atom}(d)$ the set of atoms a in D such that $a \leq d$:

$$\textsc{atom}(d) = \{a \in D : a \leq d\}$$

Definition 3.3.2 (Two-sorted Pluralized Model)**.** *A two-sorted pluralized model is a triple $\uparrow M = \langle \uparrow D, W, I\rangle$ composed of a pluralized domain of individuals $Dom_d(\uparrow M) = \uparrow D$, a domain of worlds $Dom_w(M) = W$, and an interpretation function I assigning a subset of n-tuples constructed from W and $\uparrow D$ to every n-ary predicate symbol.*

Now the language and semantic clauses in the logical system of A&D extended with plurality can be defined as follows. Note that the only difference is the adding of the term $\#z_d$, which is interpreted as the cardinality of the atomic elements that are part of z_d.

Definition 3.3.3 (Language)**.** *Given a first-order signature σ (composed of predicates $P^n \in \mathscr{P}^n$ with $n \in \mathbb{N}$), and individual variables $z_d \in \mathscr{Z}_d$ and world variables $z_w \in \mathscr{Z}_w$, the terms and formulas of our language are:*

$$t ::= z_d \mid z_w \mid \#z_d$$
$$\phi ::= P(\vec{z}) \mid \phi \wedge \psi \mid \phi \vee \psi \mid \exists_s z\phi \mid \exists_l z\phi \mid \forall z\phi \mid dep(\vec{z}, y) \mid var(\vec{z}, y)$$

Definition 3.3.4 (Interpretation of Terms)**.**

$$\begin{array}{ll} \textit{if } t = z\textit{:} & i(t) = i(z) \\ \textit{if } t = \#z_d\textit{:} & i(t) = |\textsc{atom}(i(z_d))| \end{array}$$

Definition 3.3.5 (Semantic Clauses)**.**

$$\begin{array}{lcl}
\uparrow M, T \vDash P(t_1, \ldots, t_n) & \Leftrightarrow & \forall j \in T : \langle j(t_1), \ldots, j(t_n)\rangle \in I(P^n) \\
\uparrow M, T \vDash t_1 = t_2 & \Leftrightarrow & \forall j \in T : j(t_1) = j(t_2) \\
\uparrow M, T \vDash \phi \wedge \psi & \Leftrightarrow & \uparrow M, T \vDash \phi \textit{ and } \uparrow M, T \vDash \psi \\
\uparrow M, T \vDash \phi \vee \psi & \Leftrightarrow & T = T_1 \cup T_2 \textit{ for teams } T_1 \textit{ and } T_2 \textit{ such that } \uparrow M, T_1 \vDash \phi \textit{ and } \uparrow M, T_2 \vDash \psi \\
\uparrow M, T \vDash \forall z\phi & \Leftrightarrow & \uparrow M, T[z] \vDash \phi \\
\uparrow M, T \vDash \exists_s z\phi & \Leftrightarrow & \textit{there is a strict function } f_s \textit{ such that } \uparrow M, T[f_s/z] \vDash \phi \\
\uparrow M, T \vDash \exists_l z\phi & \Leftrightarrow & \textit{there is a lax function } f_l \textit{ such that } \uparrow M, T[f_l/z] \vDash \phi \\
\uparrow M, T \vDash dep(\vec{x}, y) & \Leftrightarrow & \textit{for all } i, j \in T : i(\vec{x}) = j(\vec{x}) \Rightarrow i(y) = j(y) \\
\uparrow M, T \vDash var(\vec{x}, y) & \Leftrightarrow & \textit{there is } i, j \in T : i(\vec{x}) = j(\vec{x}) \,\&\, i(y) \neq j(y)
\end{array}$$

Definition 3.3.6 (Entailment between formulas)**.** *A formula ϕ entails a formula ψ, in symbols $\phi \vDash \psi$, if for all M and all T such that $\uparrow M, T \vDash \phi$, we have $\uparrow M, T \vDash \psi$.*

3.4 Maximality

As for the Mandarin EI *shenme*, I propose that it also has a maximality condition encoded in its semantics in addition to that of EIs.

To motivate the maximality condition, it is worth noting that now the pluralized domain consists of both atomic and plural individuals. Since I am not considering collective predicates, the interpretation function I in the logical system should ideally derive distributivity as exemplified by (7). While w_{ab} is taken as the possible world where $a \oplus b$ satisfies the property P, distributivity additionally requires a, b to satisfy P as well, with $\uparrow D = \{a, b, a \oplus b\}$. Therefore, $I(P)(w_{ab}) = \{a, b, a \oplus b\}$, and defining the interpretation function I in this way correctly captures the intuition that if Zhangsan bought two books then it follows that he bought one book as well.

(7) Distributivity: $P(a \oplus b, w_{ab}) \vDash P(a, w_{ab}) \wedge P(b, w_{ab})$

However, requiring distributivity for the interpretation function may face the following problem when dealing with *shenme*. If *shenme* is taken as only a strict existential with the variation condition standardly defined for EIs, then the semantic representation of (8-a) can be shown by (8-b) and that of (9-a) by (9-b), where P is taken as the property of being a book bought by Zhangsan.

(8) a. Zhangsan mai-le shenme shu.
Zhangsan buy-PRF what book
'Zhangsan bought (a) book(s) (and I don't know which book(s)).'
b. $\exists_s x[P(x, v) \wedge var(\varnothing, x)]$

(9) a. Zhangsan mai-le yi ben shenme shu.
Zhangsan buy-PRF one CL what book
'Zhangsan bought one book (and I don't know which book).'
b. $\exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge \#x = 1]$

As the felicity of a sentence is defined in terms of initial teams, both (8) and (9) are predicted to be felicitous for the initial team $\{w_a, w_{ab}\}$ where $I(P)(w_a) = \{a\}$ and $I(P)(w_{ab}) = \{a, b, a \oplus b\}$. Figure 3.3 shows a possible way of extension for both sentences.

v	x
w_a	a
w_{ab}	b

Figure 3.3: Both bare and non-bare *shenme* predicted to be felicitous for the initial team $\{w_a, w_{ab}\}$

However in practice, the two sentences using *shenme* are not both accepted in the situation where the speaker has the epistemic possibilities such that she knows exactly that Zhangsan bought a, while not sure about his buying b or not.[5] The intuition is that by using bare *shenme* in (10-a), the speaker conveys an ignorance for not knowing all the books that Zhangsan bought, while the unacceptability of non-bare *shenme* in (10-b) seems to result from the speaker's knowing already that Zhangsan bought a.

(10) *Context: You saw Zhangsan coming out from a bookstore with the book a on his hand, but you didn't know if he bought another book b. You said:*
a. Zhangsan mai-le shenme shu.
Zhangsan buy-PRF what book
'Zhangsan bought (a) book(s) (and I don't know which book(s)).'

[5] Some Mandarin native speakers can accept both sentences in the designated context by judging *shenme* to have an indifference reading. Namely, it does not matter in the discourse what books exactly Zhangsan bought.

b. #Zhangsan mai-le yi ben shenme shu.
Zhangsan buy-PRF one CL what book
'Zhangsan bought one book (and I don't know which book).'

The solution that I adopt in the thesis is to additionally require the value of the variable introduced by *shenme* to be maximally assigned in every possible world. The following definition of maximality is a simplified version of the exhaustification condition defined in Aloni (2007b) and Zeevat (1994) who assume exhaustification/maximality to be operative for all *wh*-pronouns. Basically, the value x is maximal with respect to the property P in the possible world v iff x is in the pluralized domain $\uparrow D$, $P(x, v)$ is true, and for all the values y in the pluralized domain $\uparrow D$: if $P(y, v)$ is true, then y is part of x.

Definition 3.4.1 (Maximality)**.** $\uparrow M, T \models max(x, v, P)$ *iff for all* $i \in T$*:* $\langle i(x), i(v)\rangle \in I_{\uparrow M}(P)$ *and for all* $d \in \uparrow D$*: if* $\langle d, i(v)\rangle \in I_{\uparrow M}(P)$*, then* $d \leq i(x)$

Therefore, I propose that the Mandarin EI *shenme* can be captured as a strict existential with the variation and maximality conditions as in (11).

(11) *shenme*: $\lambda P.\exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P)]$

With the maximality condition added, it can be seen from Figure 3.4 that (12) is still predicted to be felicitous while (13) is not. The reason is that the individual b cannot maximally satisfy P in the possible world w_{ab} where $a \oplus b$, a, and b satisfy P. More generally, the value maximally assigned to the variable x in w_{ab}, namely, $a \oplus b$, is contradictory with $\#x = 1$, and the sentence that Zhangsan bought one *shenme* book is predicted to be infelicitous whenever w_{ab} is included in the initial team.

(12) a. Zhangsan mai-le shenme shu.
Zhangsan buy-PRF what book
'Zhangsan bought (a) book(s) (and I don't know which book(s)).'
b. $\exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P)]$

(13) a. Zhangsan mai-le yi ben shenme shu.
Zhangsan buy-PRF one CL what book
'Zhangsan bought one book (and I don't know which book).'
b. $\exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P) \wedge \#x = 1]$

v	x
w_a	a
w_{ab}	$a \oplus b$

(a) Bare *shenme* supported

v	x
w_a	a
w_{ab}	b

(b) Non-bare *shenme* not supported

Figure 3.4: With the maximality condition added for the initial team $T = \{w_a, w_{ab}\}$

Note that treating *shenme* in this way also captures the following intuition where bare *shenme* carries the most generic ignorance as in (14) and (15) where the speaker does not know the number of the books being bought, or alternatively, does not know which book being bought while knowing exactly its number. Non-bare *shenme*, in contrast, is only felicitous when the speaker knows the number of the referent but fails to identify it, as in (15).[6]

(14) *Context: You saw Zhangsan coming out from a bookstore with some book on his hand, but you didn't know how many book(s) he bought. You said:*

a. Zhangsan mai-le shenme shu.
Zhangsan buy-PRF what book
'Zhangsan bought (a) book(s) (and I don't know which book(s)).'

b. #Zhangsan mai-le yi ben shenme shu.
Zhangsan buy-PRF one CL what book
'Zhangsan bought one book (and I don't know which book).'

(15) *Context: You saw Zhangsan coming out from a bookstore with a book on his hand, but you didn't know which book he bought. You said:*

a. Zhangsan mai-le shenme shu.
Zhangsan buy-PRF what book
'Zhangsan bought (a) book(s) (and I don't know which book(s)).'

b. Zhangsan mai-le yi ben shenme shu.
Zhangsan buy-PRF one CL what book
'Zhangsan bought one book (and I don't know which book).'

3.5 Summary

In this chapter, I introduced the framework of team semantics by A&D and proposed to treat the Mandarin EI *shenme* in the framework extended with plurality as a strict existential together with the conditions of variation and maximality. In Chapter 4, I will show how such an analysis of *shenme* can capture the distribution of its two forms with respect to **SU**, **co-var**, **epiU**, **deoFC**, and **NPI**, and in Chapter 5, propose a uniform account for *shenme* to be used both as an EI and as a question word.

[6]Note that the maximality condition is only required by *shenme* on the variable introduced by it. For example, (i) lists a few sentences and their (in)felicity with respect to the initial team $\{w_{ab}, w_{cd}\}$.

(i)
a. Zhangsan bought two books.
$\exists_s x[P(x,v) \wedge \#x = 2]$
b. Zhangsan bought one book.
$\exists_s x[P(x,v) \wedge \#x = 1]$
c. Zhangsan bought two *shenme* book.
$\exists_s x[P(x,v) \wedge var(\varnothing, x) \wedge max(x,v,P) \wedge \#x = 2]$
d. #Zhangsan bought one *shenme* book.
$\exists_s x[P(x,v) \wedge var(\varnothing, x) \wedge max(x,v,P) \wedge \#x = 1]$

Chapter 4

Application

Chapter 3 motivates the proposal for the Mandarin EI *shenme* to be treated as a strict existential with additionally the conditions of variation and maximality, repeated by (1).

(1) *shenme*: $\lambda P.\exists_s x[P(x,v) \wedge var(\varnothing,x) \wedge max(x,v,P)]$

In this chapter, I will show how analyzing *shenme* in this way is able to capture the behaviors of both bare and non-bare *shenme* with their distribution summarized as follows.

(1) Both bare and non-bare *shenme* can license **SU** when not embedded, **epiU** when under epistemic modals, **co-var** when combined with a universal quantifier.
(2) Bare *shenme* under negation can be interpreted to have an **NPI** interpretation, while non-bare *shenme* cannot.
(3) Embedding non-bare *shenme* under deontic modals can give rise to the use of **deoFC**. However, bare *shenme* embedded in the scope of deontic modals is judged by Law (2019) to be unacceptable.

	SU	epiU	NPI	deoFC	co-var
Bare *shenme*	✓	✓	✓	#	✓
Non-bare *shenme*	✓	✓	#	✓	✓

Table 4.1: Summary

Notably, in the following sections I will mostly work with a pluralized model with $\uparrow D = \{a, b, a \oplus b\}$. I take P generally as the property of being a book bought by Zhangsan, and w_x is a possible world with x maximally satisfying P in such a possible world.

4.1 SU

As discussed already in Chapter 3, to use *shenme* specifically requires the value of the variable x introduced by shemne to depend on v[1], and the ignorance inference is formalized by the variation condition, namely, $var(\varnothing, x)$.

[1]Note that specificity in the A&D framework amounts to $dep(v,x)$. However in the cases where there are no other operators/quantifiers, $dep(v,x)$ holds trivially for indefinites being strict existentials, and can be dropped.

The following sentence (2-a) using bare *shenme* can be formalized by (2-b). Note that specificity is trivially satisfied by the assignment extension of x being strict. The variation condition requires at least two possible values to be assigned to the variable x in the extended team, namely, $pv(x) \geq 2$. Given the maximality condition and the specific model employed here, the variation condition amounts to the initial team consisting of at least two possible worlds. In addition, every possible world in the team should be able to satisfy $P(x, w_x)$ by assigning some value to x ($w_\varnothing \notin T$). It follows that the felicity condition for the **SU** use of bare *shenme* can be captured as in (2-c).

(2) a. Zhangsan mai-le shenme shu.
Zhangsan buy-PRF what book
'Zhangsan bought (a) book(s) (and I don't know which book(s)).'
b. $\exists x_s[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P)]$
c. Felicity condition: $w_\varnothing \notin T \,\&\, pv(x) \geq 2$

Similarly, for the non-bare *shenme* as in (3) where the value assigned to x also corresponds to the number of atoms as required by the numeral classifier, the initial team should be able to license such conditions in terms of possible worlds where the maximal value for x has the exact number of atoms provided by the numeral classifier.

(3) a. Zhangsan mai-le yi ben shenme shu.
Zhangsan buy-PRF one CL what book
'Zhangsan bought one book (and I don't know which book).'
b. $\exists x_s[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P) \wedge \#x = 1]$
c. Felicity condition: $w_\varnothing \notin T \,\&\, pv(x) \geq 2 \,\&\,$ for all $i \in T : \#x = 1$

v	x
w_a	a
w_b	b

(a) Both bare and non-bare *shenme* supported

v	x
w_a	a
w_{ab}	$a \oplus b$

(b) Only bare *shenme* supported

v	x
$w_\varnothing$	a
w_{ab}	$a \oplus b$

(c) Neither bare nor non-bare *shenme* supported

v	x
w_a	a

(d) Neither bare nor non-bare *shenme* supported

Figure 4.1: SU

4.2 co-var

As for the use of **co-var** triggered by both bare and non-bare *shenme*, the distinction between the wide scope and the narrow scope readings can be captured in the framework by specifying how the variable introduced by *shenme* is related to the variable for the universal quantifier.

Take the following sentence (4) with bare *shenme* as an example. The wide scope reading requires x to refer to (a) specific book(s) bought by all the people, and therefore the value of x should remain constant once the value of v has been fixed, namely, $dep(v, x)$. As for the narrow scope reading where the book being bought is also specific to the person who bought the book, taken as the variable y, it follows that the value assigned to x also depends on the value of y, which amounts to $dep(vy, x)$.

Figure 4.2 illustrates three initial teams $\{w_{a,a}, w_{b,b}\}$, $\{w_{a,b}\}$, and $\{w_{a,a}\}$, where w_{x_1,x_2} is a possible world where only $P(x_1, p, w_{x_1,x_2})$ and $P(x_2, q, w_{x_1,x_2})$ is true, assuming p and q are the only people in the domain. While $\{w_{a,a}, w_{b,b}\}$ makes true both the wide scope and narrow scope readings, $\{w_{a,b}\}$ can only license the narrow scope reading and $\{w_{a,a}\}$ license neither readings. This essentially captures the observation that the speaker does not know the book(s) in the wide scope reading, but may or may not know who bought which book in the narrow scope reading.

(4) a. Mei ge ren dou mai-le shenme shu.
every CL person PART buy-PRF what book

b. Wide scope reading: $\forall y \exists x_s [P(x, y, v) \wedge dep(v, x) \wedge var(\varnothing, x) \wedge max(x, v, P)]$
⇝ There is/are (a) specific book(s) bought by all the people, and I don't know which book(s).

c. Narrow scope reading: $\forall y \exists x_s [P(x, y, v) \wedge dep(vy, x) \wedge var(\varnothing, x) \wedge max(x, v, P)]$
⇝ Different people bought different books. There are at least two combinations of books being bought.

v	y	x
$w_{a,a}$	p	a
$w_{a,a}$	q	a
$w_{b,b}$	p	b
$w_{b,b}$	q	b

(a) Both wide and narrow scope readings supported

v	y	x
$w_{a,b}$	p	a
$w_{a,b}$	q	b

(b) Only narrow scope reading supported

v	y	x
$w_{a,a}$	p	a
$w_{a,a}$	q	a

(c) Neither wide nor narrow scope readings supported

Figure 4.2: co-var

Non-bare *shenme* with respect to the use of **co-var** can also be captured in a similar way, only requiring the value of x to have a certain number of atoms in accordance with the combined numeral classifier.

(5) a. Mei ge ren dou mai-le yi ben shenme shu.
every CL person PART buy-PRF one CL what book

b. Wide scope reading: $\forall y \exists x_s [P(x,y,v) \wedge dep(v,x) \wedge var(\varnothing,x) \wedge max(x,v,P) \wedge \#x = 1]$
$\rightsquigarrow$ There is a specific book bought by all the people, and I don't know which book.

c. Narrow scope reading: $\forall y \exists x_s [P(x,y,v) \wedge dep(vy,x) \wedge var(\varnothing,x) \wedge max(x,v,P) \wedge \#x = 1]$
$\rightsquigarrow$ Different people bought different books. There are at least two different books being bought.

4.3 NPI

As for how negation should be defined in the framework of team semantics, Aloni and Degano (2023) following Farkas and Brasoveanu (2020) adopt an intensional notion of negation, followed by the definitions of implication and maximal team.

Definition 4.3.1 (Intensional Negation)**.** $\neg\phi \Leftrightarrow \forall w[\phi(v/w) \rightarrow v \neq w]$

Definition 4.3.2 (Implication)**.** $(\uparrow)M, T \vDash \phi \rightarrow \psi \Leftrightarrow$ *for some* $T' \subseteq T$ *such that* $(\uparrow)M, T' \vDash \phi$ *and* T' *is maximal, we have* $(\uparrow)M, T' \vDash \psi$

Definition 4.3.3 (Maximal Team)**.** *Given a (pluralized) model* $(\uparrow)M$ *and a formula* ϕ*, a team* T *maximally satisfies* ϕ *iff* $(\uparrow)M, T \vDash \phi$ *and for all* T'' *such that* $T' \subset T'' \subseteq T$*, it holds* $(\uparrow)M, T'' \nvDash \phi$

When it comes to the Mandarin EI *shenme*, the fact requiring explanation is that only bare *shenme* is able to induce the use of **NPI**, while non-bare *shenme* under negation is judged by most Mandarin native speakers to be odd. Even for those who accept the felicity of non-bare *shenme* under negation, it gives rise to a **SU** reading rather than that of **NPI**. I argue that, for the following sentences with their judgement, bare *shenme* under negation is felicitous only when no book was bought, which is exactly its **NPI** use. As for non-bare *shenme* combined with a numeral classifier *yi ben* 'one CL' in (7) and *liang ben* 'two CL' in (8), I compare their felicity condition with another construction without *shenme* – where only the numeral classifier is present – as in (9) and (10). While (10) is generally accepted, the reason for non-bare *shenme*'s oddity under negation is due to its meaning being non-convex, and (9) is generally unacceptable because it is in competition with the bare *shenme* construction as in (6), or at least so I will argue.[2]

(6) Bare *shenme*:
Zhangsan mei mai shenme shu.
Zhangsan NEG buy what book
'Zhangsan didn't buy any book.'

[2]Note that there is another construction in Mandarin to use under negation, as in (i) with only the noun *shu* 'book'. According to the intensional notion of negation defined by Aloni and Degano (2023), (i) is predicted to be semantically equivalent with its two counterparts using bare *shenme* and 'one CL'. However in practice, the negation using the bare noun tends to have a contrastive interpretation to deny only the noun being used.

(i) Zhangsan mei mai shu.
Zhangsan NEG buy book
'Zhangsan didn't buy books.'
$\rightsquigarrow$ 'Rather, Zhangsan bought pens.'

(7) One CL *shenme*:
?Zhangsan mei mai yi ben shenme shu.
Zhangsan NEG buy one CL what book
'Zhangsan didn't buy any one book.'
'Zhangsan didn't buy one specific book (and I don't know which one).'

(8) Two CL *shenme*:
?Zhangsan mei mai liang ben shenme shu.
Zhangsan NEG buy two CL what book
'Zhangsan didn't buy any two books.'
'Zhangsan didn't buy two specific books (and I don't know which two).'

(9) One CL:
*Zhangsan mei mai yi ben shu.
Zhangsan NEG buy one CL book
'Zhangsan didn't buy one book.'

(10) Two CL:
Zhangsan mei mai liang ben shu.
Zhangsan NEG buy two CL book
'Zhangsan didn't buy two books.'

Now I will move on to the predictions by my analysis with respect to these sentences.

To begin with, the construction using bare *shenme*, repeated by (11-a), has its semantic representation in (11-b). Figure 4.3 lists four cases when the initial team is $\{w_\varnothing\}$, $\{w_a\}$, $\{w_{ab}\}$, and $\{w_{abc}\}$. Note that the maximal teams satisfying the antecedent in (11-b) are depicted in blue. It can be seen that bare *shenme* in (11) is predicted to be felicitous only when the initial team is taken to be $\{w_\varnothing\}$, namely, the interpretation of **NPI** that no book was bought by Zhangsan.

(11) a. Zhangsan mei mai shenme shu.
Zhangsan NEG buy what book
'Zhangsan didn't buy any book.'
b. $\forall w(\exists_s x[P(x,w) \wedge dep(vw,x) \wedge var(\varnothing,x) \wedge max(x,w,P)] \rightarrow v \neq w)$

v	w	x
$w_\varnothing$	$w_\varnothing$	a
$w_\varnothing$	w_a	a
$w_\varnothing$	w_{ab}	$a \oplus b$
$w_\varnothing$	w_{abc}	$a \oplus b \oplus c$

(a) Initial team $T = \{w_\varnothing\}$

v	w	x
w_a	$w_\varnothing$	a
w_a	w_a	a
w_a	w_{ab}	$a \oplus b$
w_a	w_{abc}	$a \oplus b \oplus c$

(b) Initial team $T = \{w_a\}$

v	w	x
w_{ab}	$w_\varnothing$	a
w_{ab}	w_a	a
w_{ab}	w_{ab}	$a \oplus b$
w_{ab}	w_{abc}	$a \oplus b \oplus c$

(c) Initial team $T = \{w_{ab}\}$

v	w	x
w_{abc}	$w_\varnothing$	a
w_{abc}	w_a	a
w_{abc}	w_{ab}	$a \oplus b$
w_{abc}	w_{abc}	$a \oplus b \oplus c$

(d) Initial team $T = \{w_{abc}\}$

Figure 4.3: Bare *shenme*: felicitous when initial team $T = \{w_\varnothing\}$

Before moving on to non-bare *shenme*, an interesting observation for using numeral classifiers under negation is that the judgement on 'one CL' and 'two CL' also differs in (12) and (13) where *shenme* is even not present. As no maximality is required, the value assigned to the variable only corresponds to the number of atoms provided by the numeral classifier. It can be shown by Figure 4.4 that the felicity condition for 'one CL' under negation essentially amounts to the **NPI** interpretation of bare *shenme* that no book was bought by Zhangsan, and its oddity as in (12) may result from the semantic competition with using bare *shenme* in such a case.

In contrast, changing the number of the combined classifier from 'one' to 'two' as in (13) is predicted by Figure 4.5 to be felicitous when the initial team is $\{w_\varnothing\}$ and $\{w_a\}$. Namely, the negation of 'two CL' gives rise to the interpretation that Zhangsan did not buy two or more books. This is precisely what the intuition is as in (13-a).[3]

(12) a. *Zhangsan mei mai yi ben shu.
Zhangsan NEG buy one CL book
'Zhangsan didn't buy one book.'

b. $\forall w(\exists_s x[P(x,w) \wedge dep(vw,x) \wedge \#x = 1] \rightarrow v \neq w)$

(13) a. Zhangsan mei mai liang ben shu.
Zhangsan NEG buy two CL book
'Zhangsan didn't buy two books.'
$\rightsquigarrow$ 'Rather, Zhangsan bought one/#three book(s).'

b. $\forall w(\exists_s x[P(x,w) \wedge dep(vw,x) \wedge \#x = 2] \rightarrow v \neq w)$

v	w	x
$w_\varnothing$	$w_\varnothing$	a
$w_\varnothing$	w_a	a
$w_\varnothing$	w_{ab}	b
$w_\varnothing$	w_{abc}	b

(a) Initial team $T = \{w_\varnothing\}$

v	w	x
w_a	$w_\varnothing$	a
w_a	w_a	a
w_a	w_{ab}	b
w_a	w_{abc}	b

(b) Initial team $T = \{w_a\}$

v	w	x
w_{ab}	$w_\varnothing$	a
w_{ab}	w_a	a
w_{ab}	w_{ab}	b
w_{ab}	w_{abc}	b

(c) Initial team $T = \{w_{ab}\}$

v	w	x
w_{abc}	$w_\varnothing$	a
w_{abc}	w_a	a
w_{abc}	w_{ab}	b
w_{abc}	w_{abc}	b

(d) Initial team $T = \{w_{abc}\}$

Figure 4.4: One CL: felicitous when initial team $T = \{w_\varnothing\}$

As for non-bare *shenme* combined with the numeral classifier 'one CL' in (14) and 'two CL' in (15), note that the maximality condition of *shenme* requires the value of the variable to be

[3] To see why negating 'two CL' intuitively amounts to that Zhangsan did not buy two or more books, consider (i) and (ii). Only (ii) allows the contrastive marker *dan* 'but' to follow the negation of 'two CL' in the original sentence, which suggests the inference that 'Zhangsan bought one book' to be already in the meaning of the negation while the inference that 'Zhangsan bought three books' is not.

(i) Zhangsan mei mai liang ben shu. (#Dan) ta mai-le yi ben.
Zhangsan NEG buy two CL book but he buy-PRF one CL
'Zhangsan didn't buy two books. #But he bought one.'

(ii) Zhangsan mei mai liang ben shu. Dan ta mai-le san ben.
Zhangsan NEG buy two CL book but he buy-PRF three CL
'Zhangsan didn't buy two books. But he bought three.'

v	w	x
$w_\varnothing$	$w_\varnothing$	$a \oplus b$
$w_\varnothing$	w_a	$a \oplus b$
$w_\varnothing$	w_{ab}	$a \oplus b$
$w_\varnothing$	w_{abc}	$a \oplus b$

(a) Initial team $T = \{w_\varnothing\}$

v	w	x
w_a	$w_\varnothing$	$a \oplus b$
w_a	w_a	$a \oplus b$
w_a	w_{ab}	$a \oplus b$
w_a	w_{abc}	$a \oplus b$

(b) Initial team $T = \{w_a\}$

v	w	x
w_{ab}	$w_\varnothing$	$a \oplus b$
w_{ab}	w_a	$a \oplus b$
w_{ab}	w_{ab}	$a \oplus b$
w_{ab}	w_{abc}	$a \oplus b$

(c) Initial team $T = \{w_{ab}\}$

v	w	x
w_{abc}	$w_\varnothing$	$a \oplus b$
w_{abc}	w_a	$a \oplus b$
w_{abc}	w_{ab}	$a \oplus b$
w_{abc}	w_{abc}	$a \oplus b$

(d) Initial team $T = \{w_{abc}\}$

Figure 4.5: Two CL: felicitous when initial team $T = \{w_\varnothing\}, \{w_a\}$

maximally assigned in a given possible world. The intensional notion of negation predicts (14) to be felicitous for the initial team taken as $\{w_\varnothing\}$, $\{w_{ab}\}$ and $\{w_{abc}\}$, and (15) to be felicitous for $\{w_\varnothing\}$, $\{w_a\}$ and $\{w_{abc}\}$, as illustrated by Figure 4.6 and Figure 4.7 respectively (if ignoring $var(\varnothing, x)$). Therefore, according to the prediction, (14) should be rendered true if Zhangsan bought no book, or alternatively two and more books, and in a similar way (15) for the cases where Zhangsan bought no book, one book, and in addition three and more books. My explanation for the oddity of (14) and (15) is that their interpretation with respect to how many books Zhangsan bought is too much complex. Specifically, the negation of 'one CL *shenme*' and 'two CL *shenme*' both leads to a non-convex meaning, where only the exact number of books as denoted by the numeral classifier is negated. However in practice, Mandarin native speakers tend to resort to other constructions, for example, the contrastive negative marker *bushi* as in (16), to express such negation of only specific number of books. In this way, embedding non-bare *shenme* under negation is generally judged to be odd, because, on the one hand, it gives rise to a non-convex, also semantically non-desired, interpretation, and on the other hand, it is in competition with the other expression using *bushi*.

(14) a. ?Zhangsan mei mai yi ben shenme shu.
Zhangsan NEG buy one CL what book
'Zhangsan didn't buy any one book.'
b. $\forall w(\exists_s x[P(x,w) \wedge dep(vw,x) \wedge var(\varnothing,x) \wedge max(x,w,P) \wedge \#x = 1] \rightarrow v \neq w)$

(15) a. ?Zhangsan mei mai liang ben shenme shu.
Zhangsan NEG buy two CL what book
'Zhangsan didn't any two books.'
b. $\forall w(\exists_s x[P(x,w) \wedge dep(vw,x) \wedge var(\varnothing,x) \wedge max(x,w,P) \wedge \#x = 2] \rightarrow v \neq w)$

(16) Zhangsan mai-de bushi yi/liang ben shu.
Zhangsan buy-MOD not.be one/two CL book
'It is not the case that Zhangsan bought one/two book(s).'

To summarize, I have analyzed for negation three constructions in Mandarin: bare *shenme* under negation, only numeral classifiers under negation, and both *shenme* and numeral classifiers, namely, non-bare *shenme*, under negation. Table 4.2 lists the constructions analyzed so far and their corresponding interpretation, if licensed, or the reason for their ungrammaticality. Notably,

v	w	x
$w_\varnothing$	$w_\varnothing$	a
$w_\varnothing$	w_a	a
$w_\varnothing$	w_{ab}	$a \oplus b$
$w_\varnothing$	w_{abc}	$a \oplus b \oplus c$

(a) Initial team $T = \{w_\varnothing\}$

v	w	x
w_a	$w_\varnothing$	a
w_a	w_a	a
w_a	w_{ab}	$a \oplus b$
w_a	w_{abc}	$a \oplus b \oplus c$

(b) Initial team $T = \{w_a\}$

v	w	x
w_{ab}	$w_\varnothing$	a
w_{ab}	w_a	a
w_{ab}	w_{ab}	$a \oplus b$
w_{ab}	w_{abc}	$a \oplus b \oplus c$

(c) Initial team $T = \{w_{ab}\}$

v	w	x
w_{abc}	$w_\varnothing$	a
w_{abc}	w_a	a
w_{abc}	v_{ab}	$a \oplus b$
w_{abc}	v_{abc}	$a \oplus b \oplus c$

(d) Initial team $T = \{w_{abc}\}$

Figure 4.6: One CL *shenme*: felicitous when initial team $T = \{w_\varnothing\}, \{w_{ab}\}, \{w_{abc}\}$

v	w	x
$w_\varnothing$	$w_\varnothing$	a
$w_\varnothing$	w_a	a
$w_\varnothing$	w_{ab}	$a \oplus b$
$w_\varnothing$	w_{abc}	$a \oplus b \oplus c$

(a) Initial team $T = \{w_\varnothing\}$

v	w	x
w_a	$w_\varnothing$	a
w_a	w_a	a
w_a	w_{ab}	$a \oplus b$
w_a	w_{abc}	$a \oplus b \oplus c$

(b) Initial team $T = \{w_a\}$

v	w	x
w_{ab}	$w_\varnothing$	a
w_{ab}	w_a	a
w_{ab}	w_{ab}	$a \oplus b$
w_{ab}	w_{abc}	$a \oplus b \oplus c$

(c) Initial team $T = \{w_b\}$

v	w	x
w_{abc}	$w_\varnothing$	a
w_{abc}	w_a	a
w_{abc}	w_{ab}	$a \oplus b$
w_{abc}	w_{abc}	$a \oplus b \oplus c$

(d) Initial team $T = \{w_{abc}\}$

Figure 4.7: Two CL *shenme*: felicitous when initial team $T = \{w_\varnothing\}, \{w_a\}, \{w_{abc}\}$

embedding bare *shenme* in the scope of negation is predicted to exhibit the use of **NPI**, whereas non-bare *shenme* under negation results in a non-convex meaning and also the competition with *bushi*, and is therefore rendered odd.

Construction	Interpretation	Reason
bare *shenme*	0	NPI
# one CL	$\ngeq 1$	in competition with bare *shenme*
# one CL *shenme*	$\neq 1$	non-convex / in competition with *bushi*
two CL	$\ngeq 2$	
# two CL *shenme*	$\neq 2$	non-convex / in competition with *bushi*

Table 4.2: Summary

4.4 Modal

Modals are treated by Aloni and Degano (2023) in the A&D framework as quantifiers over possible worlds ($\Diamond_w \sim \exists_l w; \Box_w \sim \forall w$). Specifically, possibility modals are modelled as lax existential quantifiers taking world variables, which only require some possible world to make true the proposition, while necessity modals are universal quantifiers requiring the proposition to be satisfied in every possible world.

In addition, Aloni and Degano (2023) propose to capture the distinction between epistemic modality and deontic modality in the framework by regulating the accessibility relation of possible worlds for each of the modality. According to them, epistemic modality only allows possible worlds compatible with the current information state to be accessible. Deontic modality, in contrast, is related to particular normative rules or desires that may or may not correspond to the information of the actual world.

Taking this as a point of departure, Aloni and Degano (2023) propose the following notion of inclusion atom to capture the semantics of epistemic modality. Namely, the world variable introduced by epistemic modals is restricted to only possible worlds which v ranges over, where v is the designated variable for the actual world, and also can be taken to represent the epistemic state of the speaker.

Definition 4.4.1 (Inclusion Atom). $(\uparrow)M, T \models \vec{x} \subseteq \vec{y} \Leftrightarrow$ *for all* $i \in T$, *there is a* $j \in T : i(\vec{x}) = j(\vec{y})$

In this way, epistemic modals are treated by Aloni and Degano (2023) to introduce a world variable w with additionally the restriction $w \subseteq v$. Deontic modals are however relational, where the relation R may differ for each of the possible world. Figure 4.8 is taken from Aloni and Degano (2023), which shows some possible extensions by the epistemic modal in (17) and by the deontic modal in (18) respectively.

(17) Epistemic possibility modal:
   a. John might be in Paris.
   b. $\exists_l w[\phi(w) \wedge w \subseteq v]$

(18) Deontic possibility modal:
   a. John is allowed to be in Paris.
   b. $\exists_l w[\phi(w) \wedge R(v, w)]$ (Aloni and Degano 2023)

v
w_1
w_2
w_3

(a) Initial team

v	w
w_1	w_1
w_1	w_2
w_2	w_1
w_2	w_2
w_3	w_1
w_3	w_2

(b) Epistemic modals

v	w
w_1	w_1
w_1	w_2
w_2	w_1
w_2	w_1
w_3	w_3
w_3	w_4

(c) Deontic modals

Figure 4.8: Illustration of epistemic and deontic modals from Aloni and Degano (2023)

4.4.1 epiU

When it comes to the Mandarin EI *shenme*, combining it with epistemic modals such as the epistemic possibility modal *keneng* 'might' and the epistemic necessity modal *kending* 'must' is predicted by the framework to license both the reading of **SU** in terms of $dep(v,x)$ when *shenme* is not embedded, and the reading of **epiU** in terms of $dep(vw,x)$ when *shenme* is under epistemic modals, as shown in (19).

(19) Epistemic possibility modal (bare *shenme*):

a. Zhangsan keneng mai-le shenme shu.
   Zhangsan might buy-PRF what book
   'Zhangsan might have bought some book(s).'

b. SU: $\exists_l w \exists_s x[P(x,w) \wedge w \subseteq v \wedge dep(v,x) \wedge var(\varnothing,x) \wedge max(x,w,P)]$

c. epiU: $\exists_l w \exists_s x[P(x,w) \wedge w \subseteq v \wedge dep(vw,x) \wedge var(\varnothing,x) \wedge max(x,w,P)]$

d. Felicity condition: $pv(x) \geq 2$

Figure 4.9 and Figure 4.10 display two examples where **SU** and **epiU** are found felicitous and infelicitous for the initial team $\{w_\varnothing, w_a, w_{ab}\}$ and $\{w_\varnothing, w_{ab}\}$ respectively. Note that the A&D framework predicts **SU** and **epiU** to have the same felicity condition under epistemic possibility modals. Namely, an initial team supports **SU** iff it supports **epiU**.

It can be easily seen that the felicity condition for **SU** and **epiU** in the defined model amounts to $pv(x) \geq 2$. As the value of x is maximally assigned with respect to w, allowing x to have at least two possible values in the extended team is the same as the initial team consisting of at least two possible worlds being able to make $P(x,w)$ true in the given model. Therefore, an initial team taken in this way can make **SU** felicitous if having a strict functional extension for w with $w \subseteq v$, and also make **epiU** felicitous as $dep(v,x) \vDash dep(vw,x)$.

As for the other direction where the felicity condition is not satisfied, it follows that the variation condition $var(\varnothing,x)$ cannot be rendered true, and neither **SU** nor **epiU** is predicted to be felicitous.

v
$w_\varnothing$
w_a
w_{ab}

(a) Initial team $T = \{w_\varnothing, w_a, w_{ab}\}$

v	w	x
$w_\varnothing$	w_a	a
w_a	w_a	a
w_{ab}	w_{ab}	$a \oplus b$

(b) SU supported

v	w	x
$w_\varnothing$	w_{ab}	$a \oplus b$
w_a	w_a	a
w_{ab}	w_a	a
w_{ab}	w_{ab}	$a \oplus b$

(c) epiU supported

Figure 4.9: Felicity of SU & epiU (one of the possible extensions)

Similarly, (20), (21) and (22) exemplify *shenme* under epistemic necessity modals, non-bare *shenme* under epistemic possibility modals, and non-bare *shenme* under epistemic necessity modals, with their felicity condition also specified respectively.

v
$w_\varnothing$
w_{ab}

(a) Initial team $T = \{w_\varnothing, w_{ab}\}$

v	w	x
$w_\varnothing$	w_{ab}	$a \oplus b$
w_{ab}	w_{ab}	$a \oplus b$

(b) SU not supported

v	w	x
$w_\varnothing$	$w_\varnothing$	a
$w_\varnothing$	w_{ab}	$a \oplus b$
w_{ab}	$w_\varnothing$	a
w_{ab}	w_{ab}	$a \oplus b$

(c) epiU not supported

Figure 4.10: Infelicity of SU & epiU (one of the possible extensions)

(20) Epistemic necessity modal (bare *shenme*):

a. Zhangsan kending mai-le shenme shu.
Zhangsan must buy-PRF what book
'Zhangsan must have bought some book(s).'

b. SU: $\forall w[w \subseteq v \rightarrow \exists_s x[P(x,w) \wedge dep(v,x) \wedge var(\varnothing,x) \wedge max(x,w,P)]]$

c. epiU: $\forall w[w \subseteq v \rightarrow \exists_s x[P(x,w) \wedge dep(vw,x) \wedge var(\varnothing,x) \wedge max(x,w,P)]]$

d. Felicity condition: $w_\varnothing \notin T$ & $pv(x) \geq 2$

(21) Epistemic possibility modal (non-bare *shenme*):

a. Zhangsan keneng mai-le yi ben shenme shu.
Zhangsan might buy-PRF one CL what book
'Zhangsan might have bought one book.'

b. SU: $\exists_l w \exists_s x[P(x,w) \wedge w \subseteq v \wedge dep(v,x) \wedge var(\varnothing,x) \wedge max(x,w,P) \wedge \#x = 1]$

c. epiU: $\exists_l w \exists_s x[P(x,w) \wedge w \subseteq v \wedge dep(vw,x) \wedge var(\varnothing,x) \wedge max(x,w,P) \wedge \#x = 1]$

d. Felicity condition: $pv(x) \geq 2$ & for all $i \in T : \#x = 1$

(22) Epistemic necessity modal (non-bare *shenme*):

a. Zhangsan kending mai-le yi ben shenme shu.
Zhangsan must buy-PRF one CL what book
'Zhangsan must have bought one book.'

b. SU: $\forall w[w \subseteq v \rightarrow \exists_s x[P(x,w) \wedge dep(v,x) \wedge var(\varnothing,x) \wedge max(x,w,P) \wedge \#x = 1]]$

c. epiU: $\forall w[w \subseteq v \rightarrow \exists_s x[P(x,w) \wedge dep(vw,x) \wedge var(\varnothing,x) \wedge max(x,w,P) \wedge \#x = 1]]$

d. Felicity condition: $w_\varnothing \notin T$ & $pv(x) \geq 2$ & for all $i \in T : \#x = 1$

4.4.2 deoFC

To account for total variation under deontic modals, Aloni and Degano (2023) propose the following definition of generalized variation. Specifically, while the variation atoms defined previously only require a pair of assignments to differ in the value of the relevant variable, generalized variation requires the value of the variable to differ for at least n assignments.

Definition 4.4.2 (Generalized Variation)**.**

$var_n(\vec{x}, y) \Leftrightarrow \textit{for all } i \in T : |\{j(y) : j' \in T \textit{ and } i(\vec{x}) = j(\vec{x})\}| \geq n$

According to Law (2019), embedding non-bare *shenme* in the scope of deontic modals would give rise to total variation as licensed by **deoFC**. This can be essentially captured by strengthening the variation to the level of $|A|$ for both the deontic possibility modal in (23) and the deontic necessity modal in (24), where A is a subset of the pluralized domain consisting of only individuals having the number of atoms as required by the numeral classifier.

(23) Deontic possibility modal (non-bare *shenme*):

a. Zhangsan keyi mai yi ben shenme shu.
Zhangsan can buy one CL what book
'Zhangsan can buy any book.'

b. deoFC: $\exists_l w \exists_s x[P(x, w) \wedge R(v, w) \wedge dep(vw, x) \wedge var_{|A|}(v, x) \wedge max(x, w, P) \wedge \#x = 1]$, where $A \subseteq \uparrow D$ such that for all $a \in A : |\textsc{atom}(a)| = 1$

(24) Deontic necessity modal (non-bare *shenme*):

a. Zhangsan bixu mai yi ben shenme shu.
Zhangsan must buy one CL what book
'Zhangsan must buy a book (and any book is possible)'

b. deoFC: $\forall w[R(v, w) \rightarrow \exists_s x[P(x, w) \wedge dep(vw, x) \wedge var_{|A|}(v, x) \wedge max(x, w, P) \wedge \#x = 1]]$, where $A \subseteq \uparrow D$ such that for all $a \in A : |\textsc{atom}(a)| = 1$

To illustrate, take the accessibility relation R as defined in Figure 4.11. Figure 4.12 exemplifies two teams where (23-b) with the deontic possibility modal and (24-b) with the deontic necessity modal are supported respectively. Note that possibility modals are lax quantifiers over possible worlds, and the initial team of $\{w_1\}$, $\{w_2\}$, $\{w_3\}$, $\{w_4\}$ and any of their union is able to make (23) felicitous. In contrast, necessity modal considers all of its quantified possible worlds, and (24) is only supported for the initial team $\{w_2\}$.

Figure 4.11: Accessibility relation

As for bare *shenme* under deontic modals, it is worth noting that Law (2019) does not discuss the distinction between deontic possibility modals and deontic necessity modals, but only denies the acceptability of bare *shenme* to be embedded in the scope of whatever deontic modals to be taken. While agreeing with her judgement on deontic possibility modals[4], I find bare *shenme* to be also acceptable when embedded under deontic necessity modals in the following context.

(25) *Context: Zhangsan spent a long time reading books in a bookstore. The bookstore owner grew angry at him and said:*

[4] As for deontic possibility modals, using bare *shenme* in their scope seems generally not as good as non-bare *shenme*, which can be seen from the following example.

(i) *Context: Zhangsan, who was a book lover, was about to have his birthday. Two of his friends were discussing what gift to be bought for him. One of them said:*
Women keyi mai ?(yi ben) shenme shu.
we can buy (one CL) what book
'We can buy some book (and any book is possible).'

v	w	x
w_1	w_a	a
w_1	w_b	b
w_2	w_a	a
w_2	w_b	b
w_3	w_a	a
w_3	w_b	b
w_4	w_a	a
w_4	w_b	b

(a) Deontic possibility modal

v	w	x
w_2	w_a	a
w_2	w_b	b

(b) Deontic necessity modal

Figure 4.12: Non-bare *shenme*: deoFC

Ni bixu mai shenme shu.
you must buy what book
'You must buy some book(s).'

In addition, I observe that (25) can be followed by the response 'no' in the context of (26) where Zhangsan's option was further restricted by the book owner to two specific books. This seems to suggest that the inference drawn from (25) is of total variation that any book and even any number of book(s) is possible for Zhangsan to buy.

(26) *Context: Zhangsan spent most of his time reading two specific books, and both books became well thumbed. The bookstore owner added:*
Bu dui. Ni bixu mai zhe liang ben shu.
no right you must buy this two CL book
'No, you must buy these two books.'

Therefore, with the sentence in (25) judged felicitous, the puzzle of *shenme* with respect to deontic modals then becomes why bare *shenme* can be embedded by only deontic necessity modals whereas non-bare *shenme* can be embedded by both deontic possibility modals and deontic necessity modals.

According to the team semantics framework, bare *shenme* under the deontic possibility modal in (27) and under the deontic necessity modal in (28), if licensing total variation, are predicted to have $var_{|\uparrow D|}(v, x)$ as their variation condition. Namely, in every possible world, every value in the pluralized domain $\uparrow D$ is a possible option to be assigned for x.

(27) Deontic possibility modal (bare *shenme*):

a. *Zhangsan keyi mai shenme shu.
Zhangsan can buy what book
'Zhangsan can buy book(s).'

b. deoFC: $\exists_l w \exists_s x[P(x, w) \wedge R(v, w) \wedge dep(vw, x) \wedge var_{|\uparrow D|}(v, x) \wedge max(x, w, P)]$

(28) Deontic necessity modal (bare *shenme*):

a. Zhangsan bixu mai shenme shu.
Zhangsan must buy what book
'Zhangsan must buy book(s).'

b. deoFC: $\forall w[R(v,w) \rightarrow \exists_s x[P(x,w) \wedge dep(vw,x) \wedge var_{|\uparrow D|}(v,x) \wedge max(x,w,P)]]$

Given the accessibility relation R taken in the aforementioned way, the initial team of $\{w_3\}$, $\{w_4\}$ and also their union should be able to support (27), whereas (28) is only supported by the initial team taken as $\{w_4\}$, as can be shown by Figure 4.13.

v	w	x
w_3	w_a	a
w_3	w_b	b
w_3	w_{ab}	$a \oplus b$
w_4	w_a	a
w_4	w_b	b
w_4	w_{ab}	$a \oplus b$

(a) Deontic possibility modal

v	w	x
w_4	w_a	a
w_4	w_b	b
w_4	w_{ab}	$a \oplus b$

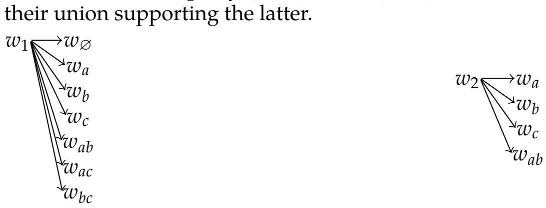
(b) Deontic necessity modal

Figure 4.13: Bare *shenme*: deoFC

If this is the case, then the framework of team semantics should make an interesting prediction with respect to the entailment relation between the following sentences in (29). To begin with, as for sentences (29-d), (29-e), and (29-f) with either bare or non-bare *shenme* under the deontic necessity modal, it follows that none of the three entails any other of them. The reason is that necessity modal takes into consideration all the possible worlds being accessible, and given the maximality condition of *shenme*, the accessible possible world satisfies either 'one *shenme*' or 'two *shenme*' cannot however satisfy the other. When it comes to deontic possibility modals, (29-a) with its predicted meaning entails both (29-b) and (29-c), as possibility modals are treated as lax quantifiers. The possible world with its accessible possible worlds having the variation with respect to the whole domain also has in its accessibility relation the variation with respect to a subset of the domain.[5]

(29) a. *Zhangsan can buy *shenme* book.
b. Zhangsan can buy one *shenme* book.
c. Zhangsan can buy two *shenme* books.

[5]Note that the entailment relation between (29-b) and (29-c) depends on the accessibility relation R to be taken. For example, given R defined in the following way, (29-c) entails (29-b), with the initial team of $\{w_1\}$ supporting the former and $\{w_1\}$, $\{w_2\}$ and their union supporting the latter.



d. Zhangsan must buy *shenme* book.
e. Zhangsan must buy one *shenme* book.
f. Zhangsan must buy two *shenme* books.

The analysis seems to partly capture the intuition in (30) that (30-a) can be rendered felicitous in the situation where Zhangsan is allowed to buy whatever book or whatvever two books, whereas (30-b) seems generally odd. The unacceptability of embedding bare *shenme* under deontic possibility modals (29-a) may result from its felicity condition being too weak, as any non-bare *shenme* as in (29-b) and (29-c) under deontic possibility modals is also entailed by it.

However, as for the example for bare *shenme* to be embedded in the scope of deontic necessity modals, adding either (29-e) or (29-f) immediately after (29-d) does not seem to result in contradiction, as shown by (30-c). The natural interpretation of (30-c) is that Zhangsan must buy one/two book(s) and whatever book / whatever two books is a possible option. The numeral classifier later added in the sentences puts an emphasis on the number of books that Zhangsan has to buy.

(30) a. Zhangsan can buy one *shenme* book, and Zhangsan can buy two *shenme* books.
b. #Zhangsan must buy one *shenme* book, and Zhangsan must buy two *shenme* books.
c. Zhangsan must buy *shenme* book, and Zhangsan must buy one/two *shenme* book(s).

Right now, I do not have a satisfactory explanation for such an issue, and will only list a few directions for future work.

(31) Future directions:
a. Treat bare *shenme* under deontic necessity modals to license **deoFC**. Then it is left to be explained why (30-c) does not lead to oddity.
b. Treat bare *shenme* under deontic necessity modals not to license **deoFC**. Rather, treat it to have an interpretation of partial variation that Zhangsan must buy book(s), where there are at least two options being possible for him. Such an interpretation is referred to by Aloni and Degano (2023) as a co-variation reading, in symbols $\forall w \exists_s x[\phi \wedge dep(vw, x) \wedge var_2(\varnothing, x)]$. Then it is left to be explained why bare *shenme* cannot have the use of **deoFC**, and in addition, why the response 'no' is felicitous in (23).

4.5 Summary

This chapter is centered on how the proposal to treat the Mandarin EI *shenme* as a strict existential with additionally the conditions of variation and maximality can be applied to account for the distribution of both bare and non-bare *shenme* with respect to the uses of **SU**, **co-var**, **epiU**, **deoFC**, and **NPI**. Specifically, I argue that the uses of **SU**, **co-var**, and **epiU** for both bare and non-bare *shenme* directly follow from the A&D framework when properly extended with an account of plurality. Bare *shenme* licenses **NPI** under negation as predicted by the intensional notion of negation, whereas negating non-bare *shenme* leads to a complex non-convex meaning and therefore oddity. As for **deoFC**, embedding non-bare *shenme* in the scope of deontic modals is predicted to license total variation if adopting the notion of generalized variation. In addition, I have challenged the judgement by Law (2019) by providing an example where bare *shenme* seems to also induce total variation under deontic necessity modals, though not being able to fully account for it, proposed a few directions for future work on such an issue.

In Chapter 5, I will move on to discuss the dual use of *shenme* both as an EI and as an interrogative word.

Chapter 5

Questions

In declaratives, Mandarin *shenme* is generally used as an existential with a conventionalized ignorance inference. For example, by using *shenme* in (1-b), the speaker suggests there to be book(s) bought by Zhangsan, but is ignorant about which book(s) exactly. In addition, as motivated already in Chapter 1, *shenme* can also be used as an interrogative word for constituent questions such as (1-a), where the speaker, also assuming the existence of book(s) bought by Zhangsan, asks for information on what particular book(s) Zhangsan bought.

(1) a. Zhangsan mai-le (san ben) shenme shu?
Zhangsan buy-PRF three CL what book
'What three books / book(s) did Zhangsan buy?'
b. Zhangsan mai-le (san ben) shenme shu.
Zhangsan buy-PRF three CL what book
'Zhangsan bought three books / (a) book(s) (and I don't know which book(s)).'

Hengeveld et al. (2022) take lexical items that can license both interrogative and indefinite uses like Mandarin *shenme* as *quexistentials*, after *question* and *existential*. They also provide the following example (2) from Dutch, where the word *wat* can be taken to mean either 'what' (2-a) or 'something' (2-b).

(2) a. Wat heeft Miranda gegeten?
QUEX has Miranda eaten
'What has Miranda eaten?'
b. Miranda heeft wat gegeten.
Miranda has QUEX eaten
'Miranda has eaten something.'

It is worth noting that by the term *quexistentials*, Hengeveld et al. (2022) indicate only words in exactly the same form for both interrogative and existential uses. If taken from a more generic point of view, the majority of the world's languages are observed to have indefinites either identical – in the sense of *quexistentials* – or related to interrogative words, and the morphological similarity between indefinites and interrogatives is known under the label *indefinite-interrogative affinity*. For example, Ultan (1978) finds 77 languages having indefinites based on question words in his sample of 79 languages, and as for Haspelmath (1997), 64 languages out of his 100-language sample are found to show such a pattern. One way to derive indefinites from interrogative words is to attach additional overt morphology, as shown in languages of Greek (3), Hungarian (4), and Kannada (Dravidian) (5).

(3) Greek:
 a. Ti efages?
 what ate.2SG
 'What did you eat?'
 b. Efages kati.
 ate.2SG something
 'You ate something.' (Hengeveld et al. 2022)

(4) Hungarian:
 a. Ki táncolt?
 who danced
 'Who danced?'
 b. Vala-ki táncolt.
 INDEF-who danced
 'Someone danced.' (Onea 2020)

(5) Kannada (Dravidian):
 a. ra:ju ellige ho:da
 Raju where went
 'Where did Raju go?'
 b. ra:ju ellig-o ho:da
 Raju where-or went
 'Raju went somewhere.' (Bhat 2004)

As for why indefinites are often found to be morphologically composed from interrogatives, an intuitive idea pointed out by Karcevski (1948) and Wierzbicka (1977) is that both indefinites and interrogatives are to some extent resulted from the speaker's ignorance. For example in (1), while both the question word *shenme* and the EI *shenme* show the speaker's lack of knowledge on what book(s) Zhangsan bought, by the interrogative use in (1-a), the speaker is interested in its answer and wants the missing information to be supplied from the hearer. In contrast, the indefinite *shenme* (1-b) signals no further interest from the speaker in knowing such an answer.

In the rest of Chapter 5, I will propose a uniform account for Mandarin *shenme* to be used both as an EI and as an interrogative word in the tradition of Partition Semantics by Groenendijk and Stokhof (1984). Specifically, I treat the denotation of the question meaning of *shenme* as a partition of the initial team. While the ignorance effect of the EI *shenme* in declaratives is induced by the variation atom $var(\varnothing, x)$ encoded in its meaning, my account of *shenme* in the interrogative use excludes initial teams where the speaker is knowledgeable. Therefore, the speaker's ignorance as indicated by *shenme* in both its EI and interrogative uses is preserved by treating in my account questions to be constructed from mostly the neutral information state, where the variation atom $var(\varnothing, x)$ is trivial.

5.1 Context and partition

In comparison with declarative sentences whose main conversational role is to provide information, interrogative sentences are generally assumed to raise issues, though also with information provided by their propositional content. In the A&D framework, the information of a sentence is construed as a set of assignments in the initial team. The issue is taken to be over the information state if all of its information adds up to that of the initial team, as in Ciardelli et al. (2018) and Groenendijk and Stokhof (1984). Following the tradition of Partition Semantics (Groenendijk and Stokhof 1984), I define the issue over the information state as a partition over the initial team (Groenendijk 1998). Conversational contexts licensing both declaratives and interrogatives are supposed to consider not only the information established during the conversation, but also the issues that have been brought up. A context in the team semantics framework is taken as a pair of an initial team supporting the information provided so far by the conversation, and also the partition of such a team in accordance with the issues raised along the way.

Definition 5.1.1 (Context)**.** *A context C is a pair of an initial team T and an issue I, which is an equivalence relation over T.*

Figure 5.1: Two partitions of T

It is worth noting that the issue of a context is taken as a partition over an initial team. The motivation is to follow the standard modelling of issues in terms of information states modeled as sets of possible worlds, namely, the initial team in the A&D framework.

While the discourse information of the context may require assignment extensions of the initial team by introducing new variables, I resort to the notion of survival, which is typically defined over information states in Dynamic Semantics (Dekker 1993). In the framework of team semantics, survival, $\preceq$, is defined as a relation between an assignment in a team before certain extension and the current team. An assignment i survives the team T iff there is an assignment $j \in T$ extended from i.

Definition 5.1.2 (Survival)**.** *$i \preceq T$ iff there is a $j \in T$ such that $i \subseteq j$.*

v	x
$w_\varnothing$	a
w_a	a
w_b	b
w_{ab}	$a \oplus b$

(a) $j \in T[\vec{x}]$

v
$w_\varnothing$
w_a
w_b
w_{ab}

(b) $i \in T$

Figure 5.2: $i \preceq T[\vec{x}]$

The partition over the initial team induced by an interrogative sentence is defined uniformly for both polar questions and constituent questions. Note that in the following definitions I extend the language with the quantifier $\exists_s x_1, \ldots, x_n$ (henceforth $\exists_s \vec{x}$), where n can be equal to 0.

Definition 5.1.3 (Interrogative Extension)**.** *$T[\exists_s \vec{x}\phi] = T'[\vec{f_s}/\vec{x}]$, where T' is a maximal subset of T such that $T'[\vec{f_s}/\vec{x}] \vDash \phi$ if there is such a unique $\vec{f_s}$, otherwise undefined.*

Definition 5.1.4 (Partition)**.** *The partition $\textsc{Part}(\exists_s \vec{x}\phi, T)$ generated by an interrogative $\exists_s \vec{x}\phi$ over the initial team T is an equivalence relation R over T such that for all $i, j \in T$, $R(i, j)$ iff*

$$i \preceq T[\exists_s \vec{x}\phi]_{\vec{x}=\vec{d}} \Leftrightarrow j \preceq T[\exists_s \vec{x}\phi]_{\vec{x}=\vec{d}} \textit{for all } \vec{d},$$

where $T_{\vec{x}=\vec{d}} = \{i \in T : i(\vec{x}) = \vec{d}\}$.

In the case of constituent questions, or *wh*-interrogatives that I would use as a term henceforth, the interrogative word introduces a new variable and extends the team by the aforementioned interrogative extension, where $\vec{x}$ is the sequence of variables added by the interrogative word(s) and ϕ is the propositional content of the interrogative sentence. The resulted team $T[\exists_s \vec{x}\phi]$ is built on a maximal subset T' of the original team T in a way to exclude the assignment where no element from the domain can be taken as the value of x to make ϕ true. The partition of *wh*-interrogatives is generated over the initial team where the assignments with the same value of x in the interrogative extension are grouped together.

It is worth noting that the strict assignment function $\vec{f_s}$ assigning the value of $\vec{x}$ for the team $T'[\vec{f_s}/\vec{x}]$ in the interrogative extension is required to be unique. To illustrate, consider Figure 5.3 where there are two ways of interrogative extension to the initial team. If this is allowed, then the interrogative sentence 'Who came?' would result in two different partitions over the same initial team.

In the Mandarin case where most of the *wh*-interrogatives are licensed by *wh*-indefinites like *shenme*, the uniqueness requirement of $\vec{f_s}$ in the interrogative extension is naturally satisfied due to the maximality condition of *shenme*, as the value of $\vec{x}$ is maximally assigned according to the truth condition of ϕ in every assignment (Figure 5.4).

v
$w_\varnothing$
w_a
w_b
w_{ab}

(a) Initial team T

v	x
w_a	a
w_b	b
w_{ab}	a

(b) Maximal subteam T' such that $T'[\vec{f_s}/\vec{x}] \vDash C(x,v)$ in interrogative extension with a non-unique $\vec{f_s}$

v	
$w_\varnothing$	
w_b	b
w_a	a
w_{ab}	a

(c) Partition

v
$w_\varnothing$
w_a
w_b
w_{ab}

(d) Initial team T

v	x
w_a	a
w_b	b
w_{ab}	b

(e) Maximal subteam T' such that $T'[\vec{f_s}/\vec{x}] \vDash C(x,v)$ in interrogative extension with a non-unique $\vec{f_s'}$

v	
$w_\varnothing$	
w_a	a
w_b	b
w_{ab}	b

(f) Partition

Figure 5.3: 'Who came?' $\exists_s x C(x,v)$

In terms of polar interrogatives, no additional variable is introduced for interrogative extension, and the resulted team $T[\exists_s \phi]$ is taken directly as a maximal subset T' of the original team T supporting ϕ. The partition of polar interrogatives is defined as an equivalence relation between assignments in the initial team that survive interrogative extension, and similarly, between those that do not survive interrogative extension.

In addition, I revise the notion of support from A&D to allow also questions to be supported in a context. A declarative sentence is supported by a context iff, as standardly in A&D, it is supported by the initial team of the context. An interrogative sentence is supported by a context

v
$w_\varnothing$
w_a
w_b
w_{ab}

(a) Initial team T

v	x
w_a	a
w_b	b
w_{ab}	$a \oplus b$

(b) Maximal subteam T' such that $T'[\vec{f_s}/\vec{x}] \models C(x,v) \wedge max(x,v,C)$ in interrogative extension with a unique $\vec{f_s}''$

v	
$w_\varnothing$	
w_a	a
w_b	b
w_{ab}	$a \oplus b$

(c) Partition

Figure 5.4: 'Who came?' $\exists_s x[C(x,v) \wedge max(x,v,C)]$

v
$w_\varnothing$
w_a
w_b
w_{ab}

(a) Initial team T

v
w_b
w_{ab}

(b) Maximal subteam $T' \models C(b,v)$

v
$w_\varnothing$
w_a
w_b
w_{ab}

(c) Partition

Figure 5.5: 'Did Bob come?' $\exists_s C(b,v)$

iff every complete true answer to the issue of the context is itself also a complete true answer to the interrogative, as defined in the tradition of Partition Semantics (Groenendijk and Stokhof 1984).

Note that some formulas in this new language (with $\exists_s \vec{x}$ introduced) can be taken either as declaratives ϕ_{decl} or as interrogatives ϕ_{int}, which can be interpreted by contexts with respect to the definition of support as well.

Definition 5.1.5 (Support in a context)**.** *A declarative ϕ_{decl} is supported by a context $C = (T, I)$ iff ϕ is supported by the initial team T of the context. Namely, $T, I \models \phi_{decl}$ iff $T \models \phi$.*
An interrogative ϕ_{int} is supported by a context $C = (T, I)$ iff the generated partition by ϕ over the initial team T, in symbols $\textsc{Part}(\phi, T)$, does not further divide the issue I of the context. Namely, $T, I \models \phi_{int}$ iff $I \subseteq \textsc{Part}(\phi, T)$.

Note that the formulas in the language can be categorized into the following types of sentences: plain declaratives that can only be interpreted as declarative sentences, plain interrogatives that can only be interpreted as interrogative sentences (also polar interrogatives by construction), and a mixed type of sentences such that sentences of this type can be interpreted as either declarative sentences or interrogative sentences depending on the context.

(6) a. Plain declaratives: ϕ without $\exists_s \vec{x}$
b. Plain interrogatives: $\exists_s \vec{x}\phi$ with $n = 0$
c. Mixed type of sentences: $\exists_s \vec{x}\phi$ with $n \neq 0$

By the aforementioned definition of support in a context, the three type of sentences can be reformulated as in (7).

(7) a. Plain declaratives: for all C, $C \not\models \phi_{int}$
b. Plain interrogatives: for all C, $C \not\models \phi_{decl}$
c. Mixed type of sentences: there are C, C' such that $C \models \phi_{decl}$ and $C' \models \phi_{int}$

Also following the definition of support in a context, we can see from Figure 5.6 that all of the three sentences – 'Amy came.', 'Did Amy come?', and 'Did Bob come?' – are supported in the given context of total information where $T = \{w_a\}$. Note that for 'Did Bob come?', its partition is generated from the maximal subteam $T' = \varnothing$.

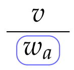
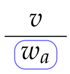
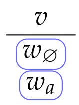


Figure 5.6: $C(a, v)$, $\exists_s C(a, v)$ and $\exists_s C(b, v)$ supported in the context

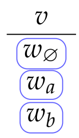
However, when it comes to *wh*-interrogatives with $var(\varnothing, x)$ assumed in their semantics, it can be seen from Figure 5.7 that the sentence 'Who came?' ($\exists_s x[C(x, v) \wedge var(\varnothing, x)]$) is only supported in (c), given the initial team T and the issue I of the context displayed by (a), (b), and (c) respectively. The reason is that in the context of (a) and (b), there is no maximal subteam $T' \subseteq T$ satisfying $var(\varnothing, x)$, and the interrogative extension by the *wh*-interrogative $\exists_s x[C(x, v) \wedge var(\varnothing, x)]$ becomes undefined. It follows that the *wh*-interrogatives with the variation atom $var(\varnothing, x)$ can never be licensed in contexts of total information, and furthermore in contexts like (b), where if the speaker knows that somebody came, then she knows who came.



(a) Not supported



(b) Not supported

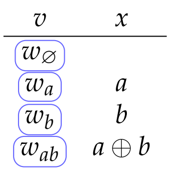


(c) Supported

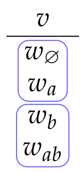
Figure 5.7: $\exists_s x[C(x, v) \wedge var(\varnothing, x)]$ supported only in (c)

Lastly, I define the entailment relation between questions following Groenendijk and Stokhof (1984). An interrogative ϕ entails an interrogative ψ iff every proposition giving a complete true answer to ϕ also gives such an answer to ψ.

Definition 5.1.6 (Entailment between questions)**.** *An interrogative ϕ_{int} entails an interrogative ψ_{int}, in symbols $\phi_{int} \vDash \psi_{int}$, if for all $C = (T, I)$ such that $T, I \vDash \phi_{int}$, we have $T, I \vDash \psi_{int}$.*



(a) 'Who came?' $\exists_s x C(x, v)$



(b) 'Did Bob come?' $\exists_s C(b, v)$

Figure 5.8: (a) entails (b)

5.2 Applications

In what follows, I will show how the proposed account can be applied to the case of Mandarin for both polar interrogatives and *wh*-interrogatives, and specifically with respect to the behavior of *shenme*.

5.2.1 Mandarin polar interrogatives

It is generally assumed that there are two types of polar interrogatives in Mandarin: *ma* questions having the question force marker *ma* at their end, and A-not-A questions formed by conjoining a constituent directly with its negative counterpart. For example, compared to the declarative sentence (8-a), the *ma* interrogative (8-b) only differs in the additional particle *ma* added to its end, and the A-not-A interrogative (8-c) repeats its verb and separates the two by attaching the negative marker *mei* in between.

(8) a. Zhangsan mai-le Zhanzhengyuheping.
Zhangsan buy-PRF war.and.peace
'Zhangsan bought *War and Peace*.'

b. Zhangsan mai-le Zhanzhengyuheping ma?
Zhangsan buy-PRF war.and.peace PART
'Did Zhangsan buy *War and Peace*?'

c. Zhangsan mai-mei-mai Zhanzhengyuheping?
Zhangsan buy-NEG-buy war.and.peace
'Did Zhangsan buy *War and Peace* or not buy?'

As pointed out by Ye (2021) and many others, A-not-A questions in Mandarin are to some extent used more restrictively than *ma* questions. Specifically, they cannot be used in biased contexts like (9) but only in neutral ones, and cannot be answered by response particles such as *dui* 'yes' in (10). For the present purpose, I will only focus on *ma* questions rather than A-not-A questions for the analysis of Mandarin polar interrogatives.

(9) *Context: Bob entered Amy's windowless room wearing a wet raincoat. Amy said:*
#Xia-mei-xia yu?
fall-not-fall rain
'Did it rain or not rain?'

(10) a. Zhangsan mai-mei-mai Zhanzhengyuheping?
Zhangsan buy-NEG-buy war.and.peace
'Did Zhangsan buy *War and Peace* or not buy?'

b. #Dui, ta mai-le Zhanzhengyuheping.
Yes he buy-PRF war.and.peace
'Yes, he bought *War and Peace*.'

Specifically, I distinguish between two instances of polar interrogatives in Mandarin: plain polar interrogatives having no *wh*-indefinites in their propositional content, and existential polar interrogatives with *wh*-indefinites at use. For example, (11-a) is a plain polar interrogative asking if Zhangsan bought a particular book, whereas (11-b), by using *shenme* as an EI in its propositional content, serves to ask in an existential way – whether there is any book bought by Zhangsan.

(11) a. Zhangsan mai-le Zhanzhengyuheping ma?
Zhangsan buy-PRF war.and.peace PART
'Did Zhangsan buy *War and Peace*?'

b. Zhangsan mai-le shenme shu ma?
Zhangsan buy-PRF what book PART
'Did Zhangsan buy book(s)?'

Notably, I take *shenme* in (11-b) to be used only as an EI rather than a question word by assuming the infelicity of *ma* when added to sentences which are already interrogatives. As shown in (12), an additional *ma* particle attached to either the plain polar interrogative (11-a) or the existential polar interrogative (11-b) would results in ungrammaticality. Therefore, I assume *ma* to be felicitous only when combined with a declarative, and specifically, to serve as the licensor of interrogative extension for polar questions.

(12) a. *Zhangsan mai-le Zhanzhengyuheping ma ma?
Zhangsan buy-PRF war.and.peace PART PART
\# 'Did Zhangsan buy *War and Peace*?'

b. *Zhangsan mai-le shenme shu ma ma?
Zhangsan buy-PRF what book PART PART
\# 'Did Zhangsan buy book(s)?'

As for how Mandarin polar questions can be captured by the aforementioned proposal, the plain polar interrogative (11-a) and the existential polar interrogative (11-b) can be formalized by (13-a) and (13-b) respectively, where $\exists_s$ is the contribution of *ma*, and P is taken as the property of being a book bought by Zhangsan. Figure 5.9 and Figure 5.10 show how the partition over the initial team $T = \{w_\varnothing, w_a, w_b, w_{ab}\}$ can be generated by (13-a) and (13-b) .

(13) a. $\exists_s P(b, v)$

b. $\exists_s[\exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P)]]$

v
$w_\varnothing$
w_a
w_b
w_{ab}

(a) Initial team T

v
w_b
w_{ab}

(b) Maximal subteam $T' \vDash P(b, v)$

v
$w_\varnothing$
w_a
w_b
w_{ab}

(c) Partition

Figure 5.9: Plain polar interrogative

v
$w_\varnothing$
w_a
w_b
w_{ab}

(a) Initial team T

v	x
w_a	a
w_b	b
w_{ab}	$a \oplus b$

(b) Maximal subteam $T' \vDash \exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P)]$

v	x
$w_\varnothing$	
w_a	a
w_b	b
w_{ab}	$a \oplus b$

(c) Partition

Figure 5.10: Existential polar interrogative

Similarly, for existential polar interrogatives like (14) including both *shenme* and a numeral classifier in their propositional content, the proposal also predicts their licensing of polar questions, as shown in Figure 5.11.

(14) a. Zhangsan mai-le yi ben shenme shu ma?
Zhangsan buy-PRF one CL what book PART
'Did Zhangsan buy one book?'

b. $\exists_s[\exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P) \wedge \#x = 1]]$

v
$w_\varnothing$
w_a
w_b
w_{ab}

(a) Initial team T

v	x
w_a	a
w_b	b

(b) Maximal subteam $T' \vDash \exists_s x[P(x,v) \wedge var(\varnothing, x) \wedge max(x,v,P) \wedge \#x = 1]$

v	x
$w_\varnothing$	
w_{ab}	
w_a	a
w_b	b

(c) Partition

Figure 5.11: Existential polar interrogative with a numeral classifier

5.2.2 Mandarin *wh*-interrogatives

When it comes to Mandarin *wh*-interrogatives, one puzzle of *shenme* is its dual use as both an EI (15-a) and an interrogative word (15-b). I argue that *shenme* in both uses would extend the team by introducing a new variable, while its interrogative use further partitions the initial team based on the values of the variable introduced by *shenme* through interrogative extension.

(15) a. Zhangsan mai-le (yi ben) shenme shu?
Zhangsan buy-PRF one CL what book
'What one book / book(s) did Zhangsan buy?'
b. Zhangsan mai-le (yi ben) shenme shu.
Zhangsan buy-PRF one CL what book
'Zhangsan bought one book / (a) book(s) (and I don't know which book(s)).'

For example, (16-a) is a *wh*-interrogative licensed by the interrogative use of *shenme* in its bare form, and can be formalized as in (16-b) where P is still taken as the property of being a book bought by Zhangsan. Notably, (16-a) is formalized in exactly the same form with its string identical declarative counterpart, which accounts for the dual use of *shenme* in both declaratives and interrogatives. Whether *shenme* is used as an EI or as a question word is dependent on the prosody of the particular sentence (Yang Yang et al. 2020).[1]

(16) a. Zhangsan mai-le shenme shu?
Zhangsan buy-PRF what book
'What book(s) did Zhangsan buy?'
b. $\exists_s x[P(x,v) \wedge var(\varnothing, x) \wedge max(x,v,P)]$

The licensing of *wh*-interrogatives by non-bare *shenme*, as in the case of (17), can be analyzed in a similar way.

[1]Note that it would be nice to show with a non-*wh*-indefinite in Mandarin that no interrogative meaning is generated because no maximality implies that the condition of unique f_s is not satisfied. However, as Mandarin does not have an explicit indefinite marker, the most common way to express indefiniteness, if not by *wh*-indefinites, is through word order and context in discourse (Wong 2016). The only non-*wh*-indefinite that I can come up with in Mandarin is *mou* 'certain', and it is true that it can never license constituent questions as an interrogative word.

(i) Zhangsan mai-le mou yi ben shu.
Zhangsan buy-PRF certain one CL book
'Zhangsan bought a certain book.'

(ii) *Zhangsan mai-le mou yi ben shu?
Zhangsan buy-PRF certain one CL book
'What book did Zhangsan buy?'

v
$w_\varnothing$
w_a
w_b
w_{ab}

(a) Initial team T

v	x
w_a	a
w_b	b
w_{ab}	$a \oplus b$

(b) Maximal subteam T' such that $T'[\vec{f_s}/\vec{x}] \models P(x,v) \wedge var(\varnothing, x) \wedge max(x,v,P)$

v	x
$w_\varnothing$	
w_a	a
w_b	b
w_{ab}	$a \oplus b$

(c) Partition

Figure 5.12: *Wh*-interrogative with bare *shenme*

(17) a. Zhangsan mai-le yi ben shenme shu?
Zhangsan buy-PRF one what book
'What one book did Zhangsan buy?'
b. $\exists_s x[P(x,v) \wedge var(\varnothing, x) \wedge max(x,v,P) \wedge \#x = 1]$

v
$w_\varnothing$
w_a
w_b
w_{ab}

(a) Initial team T

v	x
w_a	a
w_b	b

(b) Maximal subteam T' such that $T'[\vec{f_s}/\vec{x}] \models P(x,v) \wedge var(\varnothing, x) \wedge max(x,v,P) \wedge \#x = 1$

v	x
$w_\varnothing$, w_{ab}	
w_a	a
w_b	b

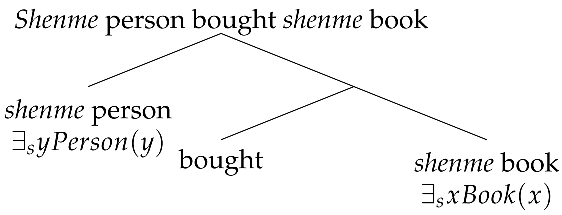
(c) Partition

Figure 5.13: *Wh*-interrogative with non-bare *shenme*

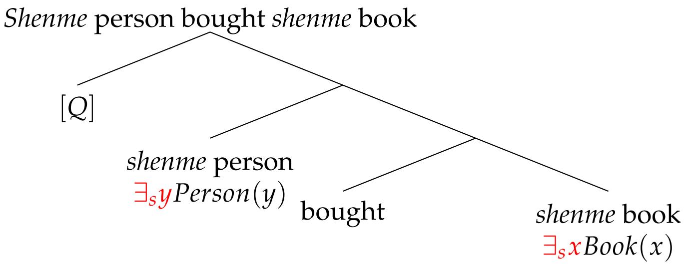
Another interesting observation is related to the use of multiple *shenme* in a sentence. Specifically, as *shenme* can be taken either as an EI or an interrogative word, the sentence (18) having two *shenme* in its propositional content can be theoretically interpreted in the following four ways: one declarative interpretation (18-a) and three interrogative interpretations (18-b), (18-c), and (18-d), where the sequence of variables for interrogative extension is marked in red.

(18) Shenme ren$_y$ mai-le shenme shu$_x$
what person buy-PRF what book
a. Declarative: 'Somebody bought some book.' $\mapsto \exists_s x \exists_s y \phi$
b. Interrogative: 'Who bought what book(s)?' $\mapsto \exists_s xy\phi$
c. #Interrogative: 'Who bought book(s)?' $\mapsto \exists_s y \exists_s x\phi$
d. Interrogative: 'What book(s) was/were bought?' $\mapsto \exists_s x \exists_s y\phi$

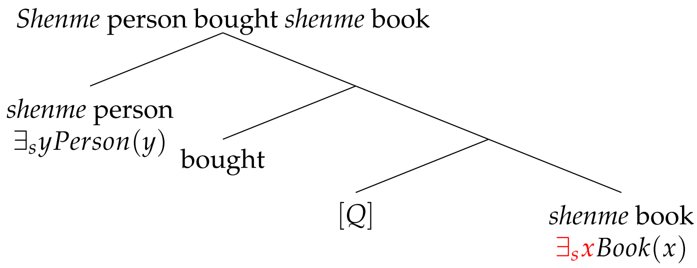
However in practice, the interrogative interpretation (18-c) with the first *shenme* in the interrogative use and the second *shenme* in the EI use is found infelicitous. One possible explanation is that the interrogative use of *shenme* also depends on certain syntactic constraint in the language of Mandarin. For example, it may be the case that the interrogative use of *shenme* is licensed by a question-related operator $[Q]$ as in Kratzer and Shimoyama (2002), which in the Mandarin case takes the maximal possible scope. As illustrated by Figure 5.14, *shenme* book is syntactically lower than *shenme* person, and therefore cannot be taken as an EI with *shenme* person in the interrogative use.



(a) Somebody bought some book.



(b) Who bought what book(s)?



(c) What book(s) was/were bought?

Figure 5.14: Multiple *shenme*

5.3 Summary

In this chapter, I have developed a uniform account for *shenme* to be used both as an EI and as an interrogative word. The following table summarizes the form of sentences with respect to their type. Declaratives are formalized as in previous chapters. Polar interrogatives are licensed in the case of Mandarin by the force marker *ma*, which gives rise to the interrogative extension with no additional variable introduced. As for *wh*-interrogatives, *shenme* in the interrogative use extends the team by a new variable, and in addition, partitions the initial team according to the values of the new variable in the interrogative extension.

Type	Form
Declarative without *wh*-indefinites	$P(a, v)$
Declarative with *wh*-indefinites	$\exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P)]$
Plain polar interrogative	$\exists_s P(a, v)$
Existential polar interrogative	$\exists_s[\exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P)]]$
Wh-interrogative	$\exists_s x[P(x, v) \wedge var(\varnothing, x) \wedge max(x, v, P)]$

Table 5.1: Summary

Notably, I have not discussed explicitly in the proposal how Mandarin declaratives and interrogatives can be combined with embedding verbs like *zhidao* 'know', *xiangzhidao* 'wonder', and *xiangxin* 'believe'. I leave the discussion for future works to use, for example, a similar approach as in Aloni (2007b).

(19) Zhangsan zhidao shenme ren lai-le.
Zhangsan know what person come-PRF
'Zhangsan knows that somebody came.'
'Zhangsan knows who came.'

(20) Zhangsan xiang zhidao shenme ren lai-le.
Zhangsan want know what person come-PRF
'Zhangsan wonders that somebody came.'
'Zhangsan wonders who came.'

(21) Zhangsan xiangxin shenme ren lai-le.
Zhangsan believe *shenme* person come-PRF
'Zhangsan believes that somebody came.'
'Zhangsan believes who came.'

In the end, I would like to conclude this chapter with an open issue raised by the variation atom $var(\varnothing, x)$ which I take to be part of the semantic contribution of *shenme*. As motivated already, my account of questions predicts the *wh*-interrogatives with the variation atom $var(\varnothing, x)$ not to be licensed in contexts of total information, as in Figure 5.15. If this is the case, then *shenme* should be judged ungrammatical in such contexts where it can never have its interrogative use and in addition its EI use as well. However in practice, *shenme* is found able to be used as an interrogative word for exam questions such as (22). At the current stage, I do not have a satisfactory answer to such an issue, and will also leave it for future works.

(22) a. *Context: A mother was telling Zhangsan's story to her child, where Zhangsan bought only one book – "War and Peace". To test if her child remembered, she asked:*
Zhangsan mai-le shenme shu?
Zhangsan buy-PRF what book

'What book(s) did Zhangsan buy?'

b. $\exists_s x[P(x,v) \wedge var(\varnothing, x) \wedge max(x,v,P)]$

v
w_a

(a) Initial team T

v	x

(b) Non-existence of maximal subteam T' such that $T'[\vec{f_s}/\vec{x}] \vDash P(x,v) \wedge var(\varnothing, x) \wedge max(x,v,P)$

v	x

(c) No partition

Figure 5.15: Exam question

Chapter 6

Conclusion

The goal of the thesis is to propose a uniform account for both the indefinite and the *wh*-interrogative use of *shenme*. Chapter 1 looks back on the historical analyses of *shenme* and sets up the stage for it to be taken as an EI, and more crucially, introduces the distribution of bare and non-bare *shenme* with respect to a group of uses that EIs can possibly license. Chapter 2 reviews the alternative based approach, the exhaustification based approach, and the conceptual cover approach as three representative approaches to EIs in general, and concludes that none of the three is able to capture the Mandarin EI *shenme* even despite its form distinction. Chapter 3 introduces the team semantics approach and proposes in the framework to analyze Mandarin *shenme* as a strict existential with additionally the conditions of variation and maximality. Chapter 4 accounts for the uses that bare and non-bare *shenme* can and cannot license as an EI. Chapter 5 presents a uniform account in the team semantics framework for *shenme* to be used as an EI in declaratives and as a question word in interrogatives.

One core aspect of my analysis of *shenme* is to treat it to have a maximality condition requiring the value of the variable introduced by *shenme* to be maximal in every possible world. The analysis is fruitful in the following ways. To begin with, the maximality condition provides a convincing explanation for why only bare *shenme* can have the **NPI** use. Negating non-bare *shenme* given the maximality condition results in the complex non-convex meaning that only nouns having the exact number of atoms in accordance with that of the numeral classifier are negated. Furthermore, the maximality condition lays the theoretical foundation for the interrogative meaning of *shenme* to be derived. Chapter 5 of this thesis proposes an account of questions in terms of Partition Semantics, and the maximality condition of *shenme* preserves the uniqueness of the partition to be generated over a given initial team.

I would like to conclude this thesis with some ideas for further research. First, the thesis only focuses on a particular *wh*-indefinite in Mandarin, namely, *shenme*. It would be interesting to compare it with other Mandarin *wh*-indefinites, and even more desirably, with *wh*-indefinites in other languages to see if the maximality condition can be generalized, and if the generalization that *wh*-indefinites are EIs is correct cross-linguistically. Meanwhile, the thesis is left with some open issues including whether the interpretation of bare *shenme* under deontic necessity modals is of total variation, and why *shenme* can still be used as a question word given a context of total information. One possible direction for solving such issues is to conduct a diachronic study on *shenme*, and hopefully, construct a grammaticalization path to find out how its EI use and interrogative use are related to each other, and in addition, to the degree reading of *shenme* (甚么) in ancient Chinese.

Appendix A

The classification of classifiers

According to Rothstein (2010a,b, 2017), counting and measuring are two distinct readings both available for classifier phrases. Specifically, "counting is putting entities into one-to-one correspondence with the natural numbers and presupposes a contextually determined decision as to what counts as an atomic entity", whereas "measuring ignores the atomic structure of a quantity, and assigns a value to that quantity, reflecting its dimension in terms of specified units on a dimensional scale" (Rothstein 2010b).

Building on Rothstein's (2010a,b, 2017) distinction between counting and measuring readings, X. Li (2011) proposes a feature analysis of Mandarin classifiers, where four types of classifiers are predicted according to the features [± Counting] (henceforth [± C]) and [± Measuring] (henceforth [± M]): [+C, −M] classifiers, [−C, +M] classifiers, [+C, +M] classifiers, and [−C, −M] classifiers.

A.1 [+C, −M] classifiers

[+C, −M] classifiers, also taken as individual classifiers, individuate the noun phrases by making available a set of atomic countable entities according to the counting unit of the classifiers themselves. In (1), *duo*, *li*, and *ben* are individual classifiers having the counting unit of 'blossom', 'grain', and 'volume' respectively, with which the noun phrases compatible with such a counting unit, namely, 'flowers', 'rice', and 'book', can be counted.

(1) a. san duo hua
three $\text{CL}_{\text{blossom}}$ flower
'three blossoms of flower'

b. yi li mi
one CL_{grain} rice
'a grain of rice'

c. liang ben shu
two $\text{CL}_{\text{volume}}$ book
'two volumes of book' (X. Li 2011)

A.2 [−C, +M] classifiers

[−C, +M] classifiers are measure classifiers that measure the quantity of entities along a certain dimension such as weight in (2), while not imposing any atomic structure on those entities. For example, (2) only implies that the weight of sugar is altogether two pounds, but it can be packed into whatever number of containers.

(2) a. liang bang tang
two CL_{pound} sugar
'two pounds of sugar' (X. Li 2011)

(3) presents another type of measure classifiers, referred to as temporary classifiers, whose measurement is in relation to a certain object and often inaccurate. (3-a), (3-b), and (3-c) refer to the sweat covering one's face, the rice strewn across the floor, and the snow drenching one's body respectively, all having a sense of hyperbole.

(3) a. yi lian hanshui
one CL_{face} sweat
'a faceful of sweat'

b. yi di mi
one CL_{floor} rice
'a floorful of rice'

c. yi shen xue
one CL_{body} snow
'a bodyful of snow' (X. Li 2011)

A.3 [+C, +M] classifiers

[+C, +M] classifiers, including container classifiers, partition classifiers, and group classifiers, can license both counting and measuring readings, as exemplified by (4), (5), and (6) respectively. In (4), *yi ping hongjiu* 'a bottle of wine' can be interpreted on the counting reading (4-a), where the speaker drank wine from a particular bottle, and also on the measuring reading (4-b), where the wine being drunk is about the capacity of one bottle. As for the partition classifier *di* in (5), the counting reading is forced in (5-a) as 'of different sizes' requires the modified entities to be plural. (5-b), in contrast, licenses also the measuring reading, where the amount of ink being used for the article adds up to three drops. Similarly, in (6), *liang pai xuesheng* 'two rows of students' can have either the counting reading (6-a) or the measuring reading (6-b): the former requires two distinct rows of students, whereas the latter only requires the number of students to be about two rows.

(4) a. Wo he-le yi ping hongjiu.
I drank-PRF one $\text{CL}_{\text{bottle}}$ red-wine
'I drank a bottle of wine.'

(5) a. Wo de bai tixu shang you san di daxiaobuyi de moshui.
I MOD white T-shirt on have three CL_{drop} big.small.not.same MOD ink
'There are three spots of ink of different sizes on my white T-shirt.'

b. Xie zhe pian wenzhang wo yong-le san di moshui.
write this CL article I use-PRF three CL_{drop} ink
'I used three drops of ink to write this article.'

(6) a. You liang pai xuesheng chao wo zou lai, qianmian yi pai, houmian yi pai.
have two CL_{row} student toward me walk come front one CL_{row} back one CL_{row}
'Two rows of students are walking toward me. One in the front and one in the back.'

b. Zhe ge jiaoshi zhi neng rongxia liang pai xuesheng.
this CL classroom only can contain two CL_{row} student
'This classroom can only hold two rows of students.' (X. Li 2011)

A.4 [−C, −M] classifiers

[−C, −M] classifiers are kind classifiers, which turn a kind of entities into a set of subkinds of those, while the subkind is neither a counting nor a measuring unit. For example, (7-a) refers to the species of the fish in general, and (7-b) three genres of books.

(7) a. yi zhong yu
one CL_{kind} fish
'one kind of fish'

b. san lei shu
three CL_{class} book
'three classes of books' (X. Li 2011)

Appendix B

Two analyses on classifiers

To account for why classifiers are required between numerals and their modified nouns, Chierchia (1998, 2010) and Krifka (1995) hold two distinct views on the roles of classifiers.

B.1 Classifiers for nouns

Chierchia (1998, 2010) starts from nouns and suggests all the Mandarin nouns to be like English mass nouns in that they lexically refer to kinds. Hence, a classifier is always required to individuate such nouns to an appropriate counting level. With the illustrations from Bale and Coon (2014) and Y.-H. Chen (2023) followed, (1) shows that Mandarin nouns (1-a) are similar to English mass nouns (1-b) as both are kind terms, whereas English count nouns (1-c) behave differently. Note that DOG is the property of being a dog, $^{\cap}$ is the function from properties to kinds, and $^{\cup}$ is the function from kinds to properties.

(1) a. $[\![\text{gou}]\!]$'dog' $=^{\cap}$ DOG (i.e., the dog-kind)
b. $[\![\text{jiaju}]\!]$'furniture' $=^{\cap}$ FURNITURE (i.e., the furniture-kind)
c. $[\![\text{dog}]\!] = \{x : \textsc{atom}(x) \wedge \text{dog}(x)\}$ (i.e., a set of individual dogs)

Chierchia's (1998, 2010) analysis of numerals and classifiers is illustrated by (2), where ATOMIC is a function true of predicates on atoms, μ_{card} is a measure function from a group to the cardinality of that group, and $*$ is a closure operator from a set of entities to the set of all sums that can be formed from those entities. The numeral *liang* 'two' is the function from atomic sets to sets of sums of two members from the atomic set.

(2) a. $[\![\text{liang}]\!]$'two' $= \lambda P : \textsc{atomic}(P).\{x : *P(x) \wedge \mu_{\text{card}}(x) = 2\}$
b. $[\![\text{zhi}]\!]_{\textsc{cl}} =^{\cup}$

The combination of Mandarin classifiers and nouns is semantically equivalent to English count nouns, as shown by (3).

(3) $[\![\text{zhi}]\!]([\![\text{gou}]\!]) = \text{DOG} = \{x : \textsc{atom}(x) \wedge \text{dog}(x)\} = [\![\text{dog}]\!]$

To sum up, Chierchia (1998, 2010) proposes a uniform interpretation of numerals in both classifier and non-classifier languages, and, by assuming that all the Mandarin nouns are mass, predicts Mandarin's lack of morphological marking for singularity and plurality, and the requirement of a classifier to turn the kind denoted by the Mandarin noun into the set of individual instances of such a kind. Therefore, Mandarin classifiers are required due to the mass of nouns.

B.2 Classifiers for numerals

In contrast, Krifka (1995) proposes an alternative analysis to treat Mandarin nouns the same as English count nouns, as shown in (4), while Mandarin numerals differ from English numerals in that they do not encode the cardinality function, which is however provided by classifiers.

(4) $[\![\text{gou}]\!]$'dog' $= \{x : \textsc{atom}(x) \wedge \text{dog}(x)\} = [\![\text{dog}]\!]$

(5) exemplifies Krifka's (1995) analysis of numerals: English *two* (5-a) has an incorporated cardinality function and can combine directly with nouns, whereas in the Mandarin case, *liang* 'two' does not have the cardinality function incorporated into its semantics, and hence requires classifiers such as *zhi* to introduce such cardinality function for it to combine with nouns.

(5) a. $[\![\text{two}]\!] = \lambda P : \textsc{atomic}(P).\{x : *P(x) \wedge \mu_{\text{card}}(x) = 2\}$
b. $[\![\text{liang}]\!]$'two' $= \lambda m \lambda P : \textsc{atomic}(P).\{x : *P(x) \wedge m(x) = 2\}$
c. $[\![\text{zhi}]\!]$CL $= \mu_{\text{card}}$

According to Krifka (1995), the combination of Mandarin numerals and classifiers is semantically equivalent to English numerals, as shown by (6).

(6) $[\![\text{liang}]\!]([\![\text{zhang}]\!]) = \lambda P : \textsc{atomic}(P).\{x : *P(x) \wedge \mu_{\text{card}}(x) = 2\} = [\![\text{two}]\!]$

On this view, Mandarin nouns are assumed to share the same semantics with English count nouns, which accounts for the optionality of classifiers by allowing Mandarin nouns to also individuate. The core difference between Mandarin and English, however, lies in numerals, as the cardinality function is not encoded in Mandarin numerals but rather in classifiers. Therefore, Mandarin classifiers are required for numerals.

Appendix C

The two-sorted team semantics framework

Definition C.0.1 (Two-sorted Model). *A two-sorted model is a triple $M = \langle D, W, I \rangle$ composed of a domain of individuals $Dom_d(M) = D$, a domain of worlds $Dom_w(M) = W$, and an interpretation function I assigning an element of D to every individual constant symbol and a subset of n-tuples constructed from W and D to every n-ary predicate symbol.*

Definition C.0.2 (Variable Assignments). *Given a two-sorted first-order model $M = \langle D, W, I \rangle$ and a set of variables $Z = Z_d \cup Z_w$, an assignment i is a function from Z such that $i(z) \in D$ if $z \in Z_d$ and $i(z) \in W$ if $z \in Z_w$. For any variable z_* and any element e_* with $* \in \{d, w\}$, we write $i[e_*/z_*]$ for the assignment function with domain $Z \cup \{z_*\}$ such that for all variable symbols $l \in Z \cup \{z_*\}$:*

$$i[e_*/z_*](l) = \begin{cases} e_* & \text{if } l = z_* \\ i(l) & \text{otherwise} \end{cases}$$

Definition C.0.3 (Team). *Given a two-sorted first-order model $M = \langle D, W, I \rangle$ and a set of variables $Z = Z_d \cup Z_w$, a team T over M with domain $Dom(T) = Z$ is a set of assignments i with domain Z.*

T	v	x
i_1	w_1	d_1
i_2	w_2	d_2

Table C.1: Example of a two-sorted first order team $T = \{i_1, i_2\}$ with domain $Z = \{v, x\}$, $D = \{d_1, d_2\}$, and $W = \{w_1, w_2\}$ from Aloni and Degano (2022)

Definition C.0.4 (Initial Team). *A team T is initial iff $Dom(T) = \{v\}$.*

Definition C.0.5 (Felicitous Sentence). *A sentence ϕ is felicitous/grammatical if there is an initial team T over the model M which supports it. Namely, $M, T \vDash \phi$.*

Definition C.0.6 (Universal Extension). *Given a model $M = \langle D, W, I \rangle$, a team T and a variable z_* with $* \in \{d, w\}$, the universal extension of T with z_*, $T[z_*]$ is defined as follows:*

$$T[z_*] = \{i[e_*/z_*] : i \in T \text{ and } e_* \in Dom_*(M)\}$$

Definition C.0.7 (Strict Functional Extension). *Given a model $M = \langle D, W, I\rangle$, a team T and a variable z_* with $* \in \{d, w\}$, the strict functional extension of T with z_*, $T[f_s/z_*]$ is defined as follows:*

$$T[f_s/z_*] = \{i[f_s(i)/z_*] : i \in T\}, \text{for some strict function } f_s : T \to Dom_*(M)$$

Definition C.0.8 (Lax Functional Extension). *Given a model $M = \langle D, W, I\rangle$, a team T and a variable z_* with $* \in \{d, w\}$, the lax functional extension of T with z_*, $T[f_l/z_*]$ is defined as follows:*

$$T[f_l/z_*] = \{i[e_*/z_*] : i \in T \text{ and } e_* \in f_l(i)\}, \text{for some lax function } f_l : T \to \wp(Dom_*(M))\backslash\{\varnothing\}$$

v	T
w_1	i_1
w_2	i_2

(a) Initial team

v	x	$T[x]$
w_1	$\to d_1$	i_{11}
	$\to d_2$	i_{12}
w_2	$\to d_1$	i_{21}
	$\to d_2$	i_{22}

(b) Universal x-extension

v	x	$T[f_s/x]$
w_1	$\to d_1$	i_{11}
w_2	$\to d_2$	i_{22}

(c) Strict functional x-extension

v	x	$T[f_l/x]$
w_1	$\to d_2$	i_{12}
w_2	$\to d_1$	i_{21}
	$\to d_2$	i_{22}

(d) Lax functional x-extension

Table C.2: Assignment extension with $D = \{d_1, d_2\}$ from Aloni and Degano (2022)

Definition C.0.9 (Dependence Atom).
$M, T \vDash dep(\vec{x}, y) \Leftrightarrow$ *for all* $i, j \in T : i(\vec{x}) = j(\vec{x}) \Rightarrow i(y) = j(y)$

Definition C.0.10 (Variation Atom).
$M, T \vDash var(\vec{x}, y) \Leftrightarrow$ *there is* $i, j \in T : i(\vec{x}) = j(\vec{x})$ & $i(y) \neq j(y)$

T	x	y	z	l
i	a_1	b_1	c_1	d_1
j	a_1	b_1	c_2	d_1
k	a_3	b_2	c_3	d_1

$dep(x, y)$ ✓	$var(x,z)$ ✓
$dep(\varnothing, l)$ ✓	$var(\varnothing, x)$ ✓
$dep(xy, z)$ #	$var(x,y)$ #

Table C.3: Illustration of dependence and variation atoms from Aloni and Degano (2022)

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