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Mandarin is a *wh*-in-situ language, in which *wh*-words remain at their base position just as their declarative counterparts do. Mandarin is also known to be a *wh*-indeterminate language, in which *wh*-words \(^1\) such as *shénme*, can have an interrogative interpretation ‘what’ or a non-interrogative existential interpretation ‘something’. Due to the *wh*-in-situ and *wh*-indeterminates nature of Mandarin, clausal typing (e.g. classify the clause as a *wh*-question) in Mandarin and the licensing of Mandarin *wh*-indeterminates have long been two intriguing topics. This dissertation investigates the clausal typing in Mandarin and the licensing of Mandarin *wh*-indeterminates, from the perspective of prosody and processing. In section 1.1, I briefly introduce what *wh*-in-situ questions, *wh*-indeterminates and clausal typing are, compare three *wh*-in-situ and *wh*-indeterminate languages and motivate why Mandarin *wh*-indeterminates require further investigations. In section 1.2, I present my research questions in this dissertation. In the final section, I conclude this chapter by providing an overview of the dissertation.

### 1.1 Background

#### 1.1.1 An introduction to *wh*-in-situ, *wh*-indeterminates and clausal typing

Human languages are diversified on the surface. For instance, when asking a *wh*-question, most Indo-European languages (e.g. English) front their *wh*-words to the clause initial position while most East Asian languages (e.g. Mandarin) tend to keep the *wh*-words in their base position. This is a common typological distinction among languages based on the formation of *wh*-questions, with the former known to be *wh*-movement languages and the latter *wh*-in-situ languages (see Cheng, 1991, among others for a detailed discussion of the typology of *wh*-questions). Examples (1) and (2) illustrate the two types of *wh*-questions respectively.

(1) What, did John buy it? [wh-movement]

(2) Zhang San mài-le shénme (ne\(^ 2\))?
Zhang San buy-PERF what (SFP)
‘What did Zhang San buy?’

The distinction of *wh*-movement languages and *wh*-in-situ languages are based on the way *wh*-questions are formed. Looking at the interpretations of *wh*-words, there are languages that are known to be *wh*-indeterminate languages such as Japanese,

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\(^1\) Unless specially mentioned, all the *wh*-words refer to arguments such as *what* and *who*, instead of adjuncts such as *why* and *how*. It should be noted that not all *wh*-words are *wh*-indeterminates, e.g., adjuncts such as *why.*

\(^2\) The sentence final particle (SFP) *ne* is optional in Mandarin.
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Korean, Mandarin and Vietnamese, in which wh-words can have both interrogative and non-interrogative interpretations (Kuroda, 1965; Huang, 1982; Nishigauchi, 1990; Cheng, 1991, 1994; Lin, 1998, 2014, among others). In these languages, wh-words have no inherent quantificational force and behave like variables (Cheng, 1991), whose interpretations are subject to licensing by (sentential) operators or licensors. Under different operators or licensors, wh-words can have interrogative, universal, existential or free choice interpretations. Take Mandarin for example. As illustrated in (3a-b), a maximality operator (e.g. dōu ‘all’) can license the universal interpretation of the wh-word shénme ‘everything’ (see Giannakidou & Cheng, 2006; Xiang, 2008; Cheng, 2009 for the analysis of dōu as a maximality operator) and a nonveridical context (like negation) can license the existential interpretation of the same wh-word shénme ‘something/anything’. Henceforth, I refer to the wh-word as a wh-existential when it is interpreted as an existential as in (3b). For declaratives containing wh-existentials like (3b), I refer to them as wh-declaratives, in order to distinguish them from regular declaratives.

(3) a. 张三 什么 都 买。
Zhāng Sān shénme dōu mǎi.
Zhang San shenme all buy
’Zhang San buys everything.’

b. 张三 不想 买 什么。
Zhāng Sān bùxiǎng mǎi shénme.
Zhang San not want buy shenme
’Zhang San doesn’t want to buy anything.’

As illustrated in (4), when there is no overt licensor, the sentence containing the same wh-word shénme is interpreted as a wh-question, with the wh-word licensed by the null interrogative operator (Q) at Spec-CP or C⁶. Henceforth I refer to the wh-word as a wh-interrogative when it is interpreted as a question word as in (4). According to Tsai (1994, 1999), all the licensors/operators of Mandarin wh-words are merged at the CP level and hence a wh-interrogative can only be interpreted at the sentence level.

(4) (+Q) 张三 买了 什么?
Zhāng Sān mǎi-le shénme?
Zhang San buy-PERF shenme
’What did Zhang San buy?’

The free choices conditions are more complicated to be generalized, see Cheng and Giannakidou (2013) for the licensing details of free choice interpretations in Mandarin.

We will briefly introduce nonveridical contexts in section 1.1.2. The definition and all the examples of “nonveridicality” will be given at length in chapter 4.

Wh-existentials can also be licensed in non-declaratives contexts which will be introduced in example (7) but in this dissertation, we mainly focus on wh-existentials in declaratives for the ease of discussing clausal typing of questions and declaratives.

⁶ From here on, I gloss shénme simply as SHENME, as it can have different interpretations.
One typical question concerning wh-in-situ languages is the question of how clausal typing is realized in these languages. According to the Clausal Typing Hypothesis by Cheng (1991: 29), “Every clause needs to be typed. In the case of typing a wh-question, either a wh-particle in C0 is used or else fronting of a wh-word to the Spec of C0 is used, thereby typing a clause through C0 by spec-head agreement.” Hence wh-movement languages such as English type their wh-questions by fronting their wh-words, while wh-in-situ languages realize that by utilizing a wh-particle. For instance, in Japanese the presence of ka at clause final position (e.g., C0) can type a wh-question. However, this hypothesis requires further considerations. Taking Mandarin as an example, it is problematic to take the particle in wh-questions (ne, a type of SFP) to be a wh-particle: First, ne is optionally used in wh-questions; second, ne appears in matrix wh-questions but it does not appear in embedded wh-questions; third, in addition to wh-questions, ne is also used in A-not-A questions; moreover, ne appears not only in questions, with a different prosody it can also appear in declaratives (Li, 2006; Constant, 2014). If wh-particles and the movement of wh-words are not present to type a wh-question, then how is clausal typing realized in a language like Mandarin?

Recent studies also show that sentence final particles and some specific intonation are in complementary distribution (Zhang, 2014; Tang, 2015; Wakefield, 2016), and a strong version of the relations between particles and intonation claims that intonation and sentence final particles are the same thing, just in different forms (Wakefield, 2016). Based on an analysis of the historical changes of Mandarin particles, tones and intonations, Feng (2015) proposes that Mandarin particles can be analyzed as a variant of intonation with the former being a segmental realization of the latter. If there is indeed such a correlation between sentence final particles and intonation, it indicates that intonation or prosody could potentially do the clausal typing for wh-questions. Although this line of analysis requires more empirical and theoretical support, it may shed light on an alternative analysis of clausal typing, namely, from the perspective of intonation/prosody. This is one of the aims of this dissertation, i.e., to investigate whether and how prosody types sentences containing wh-words (i.e. to differentiate questions from declaratives) when there is no wh-movement or particles.

Japanese, Korean and Mandarin are the three commonly discussed wh-in-situ and wh-indeterminate languages. Although in this dissertation I investigate the licensing and clausal typing of wh-indeterminates in Mandarin, with a focus on wh-interrogatives in questions and wh-existentials in declaratives, I briefly compare wh-interrogatives and wh-existentials in Japanese and Korean with that in Mandarin, through which I show that the case of Mandarin merits further investigations.

1.1.2 Wh-indeterminates in Japanese, Korean and Mandarin

Different from Mandarin, which bears a Subject-Verb-Object (SVO) word order and does not allow scrambling, both Japanese and Korean bear an SOV word order and

7 A-not-A question is a type of yes-no question in Mandarin (and other Chinese languages) offering a choice between an affirmative sentence and its negative counterpart.
allow the scrambling of \textit{wh}-words. For the ease of comparisons with Mandarin, I focus on the unmarked word order of Japanese and Korean (SOV) instead of the scrambled version. I discuss the licensing of \textit{wh}-interrogatives and \textit{wh}-existentials in these two languages and the clausal typing of questions and declaratives containing them, as compared with Mandarin.

\textbf{Japanese.} As mentioned above, Japanese is also a \textit{wh}-indeterminate language where \textit{wh}-words can have interrogative or non-interrogative interpretations, depending on the particles (Kuroda, 1965; Nishigauchi, 1990). According to Tsai (1994, 1999), different from Mandarin in which \textit{wh}-words can only be interpreted at the CP level, Japanese \textit{wh}-words can be licensed at a lower level by particles and thus interpreted at the DP level. For instance, the \textit{wh}-word \textit{dare} has the existential interpretation of ‘someone’ when combined with particle \textit{ka} as in \textit{dare-ka}, as shown in (5a). Particles in Japanese can license the interpretations of \textit{wh}-words as operators license variables (Cheng, 1991; Watanabe, 1992). When no other particles are used, a sentence-final \textit{wh}-particle \textit{no/ka} at Spec-CP or C\textsuperscript{o} can license the interrogative reading yielding a \textit{wh}-question, as illustrated in (5b).

(5) a. Dare-ka-kara henna tegami-ga todoi-ta.
   DARE-some-from strange letter-Nom arrived
   'A strange letter came from someone.'

b. Dare-ga ki-masu-ka?
   DARE-Nom come-Q
   'Who’s coming?'

As for clausal typing, the use of \textit{wh}-particles \textit{ka/\textit{no}}\textsuperscript{8} sentence finally can already type \textit{wh}-questions, according to Cheng (1991). Recent prosodic studies also demonstrate that \textit{wh}-questions are marked with a post-\textit{wh}-word lexical accents compression (Deguchi & Kitagawa, 2002; Ishihara, 2002, 2003; Kitagawa & Fodor, 2003, among others). A strong version based on the prosodic markings of \textit{wh}-questions even claims that the post-\textit{wh}-word compression not only marks the clause type but also allows Japanese \textit{wh}-questions to have \textit{wh}-in-situ. According to Richards (2010: 145), “languages try to create a prosodic structure for \textit{wh}-questions in which the \textit{wh}-phrase and the corresponding C\textsuperscript{o} (clausal-final particle \textit{no/ka} in Japanese) are separated by as few prosodic boundaries as possible.” Japanese creates this prosodic structure through the post-\textit{wh}-word compression (so that the \textit{wh}-phrase and the corresponding C\textsuperscript{o} have few prosodic boundaries in between) and hence Japanese \textit{wh}-questions can have \textit{wh}-in-situ (Richards, 2010; 2016).

\textbf{Korean.} Similar to Japanese, Korean is also a \textit{wh}-indeterminate language where the interpretations of \textit{wh}-words largely depend on particles. For example, \textit{wh}-word

\begin{footnotesize}
\begin{itemize}
\item The usage of \textit{no/ka} in Japanese \textit{wh}-questions is optional under some conditions (Yoshida & Yoshida, 1997). But the optionality of particles in Japanese appears to be more restricted than in Mandarin. Recently, it has been claimed that \textit{no} has some pragmatic functions; for instance, its presence is associated with certain presuppositions (see Sudo, 2013). As the pragmatic usage of particles is not directly relevant to our study, we still describe the presence of particles \textit{ka/\textit{no}} at the clause-final as a way to identify questions in Japanese.
\end{itemize}
\end{footnotesize}
nwukwu has the existential interpretation of ‘someone’ when combined with particle (i)nka or (i)nci as in nwukwu-(i)nka/(i)nci, as illustrated in (6a). When no other particles are used, a sentence-final wh-particle ni at Spec-CP or C° can license the interrogative reading, as illustrated in (6b).

   nwukwu-some-Nom came-Dec
   ‘Someone came.’

   b. Nwukwu-ka wass-ni?
   nwukwu-Nom came-Q
   ‘Who came?’

As for clausal typing, particles can do the job but they are optionally used in Korean. Korean also utilizes prosody, especially pitch accent and prosodic phrasing to differentiate wh-questions and declarative s containing wh-words. Normally a wh-interrogative bears a high-pitch accent and a wh-existential bears a low-pitch accent; wh-questions are characterized by a post-wh-word de-phrasing, namely, a deletion of accentual phrasings following the wh-word (Jun & Oh, 1996; Shin, 2005; Yun, 2012).

Although Japanese, Korean and Mandarin are all wh-indeterminate and wh-in-situ languages, the licensing of wh-indeterminates in Japanese and Korean in general depends on particles and the clausal typing of wh-questions relies on wh-particles or perhaps both wh-particles and prosody. As opposed to Japanese and Korean, the licensing of wh-indeterminates (wh-interrogatives and wh-existentials) and clausal typing in Mandarin are less straightforward. I will elaborate on it in two points.

First, with respect to the licensing of wh-indeterminates, Mandarin has no particles like Japanese and Korean to license wh-indeterminates and the particle ne is optionally used in wh-questions. Wh-existentials have been proposed to be licensed by nonveridical contexts only, in which the truth of a proposition cannot be entailed in the sentence. Examples (7a-d) illustrate typical nonveridical contexts, containing nonveridical operators like negation, questions, conditionals and epistemic modalities (Li, 1992; Lin, 1998; Xie, 2007; Lin, Weerman & Zeijlstra, 2014; Huang, 2017).

(7) a. 张三不想买什么。 [negation]
   Zhāng Sān bùxiǎng mǎi shénme.
   Zhang San not want buy SHENME
   ‘Zhang San doesn’t want to buy anything.’

   b. 张三买了什么吗? [yes-no question]
   Zhāng Sān mǎi-le shénme ma?
   Zhang San buy-PERF SHENME yes-no particle
   ‘Did Zhang San buy anything?’
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c. 如果 张三 买了 什么，别 生气。 [conditionals]
Rúguò Zhāng Sān mǎi-le shénme, bié shēngqì.
If Zhang San buy-PERF SHENME don’t angry

‘If Zhang San buys something, please don’t be angry at him.’

d. 可能 张三 要去 买 什么。 [epistemic modality]
Kěnéng Zhāng Sān yàoqù mǎi shénme.
Possibly Zhang San go buy SHENME

‘Possibly, Zhang San goes to buy something.’

Nevertheless, we observe that counter-examples also exist in which wh-existentials are licensed in veridical contexts. For instance, sentences in (8), which contain an adverb zúotiān (‘yesterday’) and a perfective maker le are typical veridical contexts, whose truth value is already ascertained. Yet the wh-word shénme can still have an existential interpretation. This observation challenges the general assumption in previous studies that wh-existentials are licensed in nonveridical contexts only (Lin, 1998; Xie, 2007; Lin et al., 2014; Huang, 2017), showing that the existing licensing conditions of Mandarin wh-existentials need to be revised.

(8) a. 张三 昨天 买了 点儿 什么 [veridical context]
Zhāng Sān zúotiān mǎi-le diǎnr shénme
Zhang San yesterday buy-PERF a.little SHENME
‘Zhang San bought a little of something yesterday.’ or
‘What did Zhang San buy (a little of) yesterday?’

b. 李四 昨天 买了 个 什么 [veridical context]
Lǐ Sì zúotiān mǎi-le gè shénme
Li Si yesterday buy-PERF CL SHENME
‘Li Si bought something yesterday.’ or
‘What did Li Si buy yesterday?’

Second, with respect to clausal typing, Mandarin has neither wh-movement nor reliable wh-particles to type the wh-question. Furthermore, even if Mandarin can potentially utilize prosody to type clauses (as discussed in section 1.1.1), it cannot use the same post-wh-word lexical accent/accent phrase compression as in Japanese and Korean to disambiguate wh-questions from wh-declaratives, as Mandarin is a tone language with no lexical accent or accent phrase. It hence raises an additional point concerning clausal typing based on prosody. In particular, if prosody can do clausal typing in Mandarin, is there a specific clausal typing region in the sentence (pre-wh-word region, wh-word itself, post-wh-word region) or is the whole sentence marked with distinctive prosody? Both Korean and Japanese report that wh-questions are marked with a lexical accent/accent phrase compression in the post-wh-word region. But it remains unknown whether it is only the prosodic marking in the post-wh-word region or wh-word itself that can mark the clause type. Furthermore, different from Korean and Japanese which are SOV languages, Mandarin is SVO and when the question word is an object, the post-object or post-
wh-region is in fact very limited (see Huang, 1984 for the details). The longer pre-wh-word region in Mandarin as opposed to Korean and Japanese raises the question of whether the pre-wh-word region also plays a role in clausal typing, especially from the perspective of perception. In other words, whether listeners can identify the clause types in the pre-wh-word region based on prosody would be interesting to investigate. Taken together, different from Korean and Japanese in which the post-wh-word regions are often the focus for investigation, in Mandarin, it will be insightful to also investigate the prosodic markings of the pre-wh-word regions in wh-questions and wh-declaratives, for a better understanding and a complete picture of clausal typing in Mandarin.

In short, the clausal typing in Mandarin based on prosody needs to be thoroughly investigated, especially in the pre-wh-word region. Further investigations are also required to explore the detailed constraints and evidence in the licensing of wh-indeterminates in Mandarin, through for instance, investigating the cases where wh-existentials are licensed in wh-declaratives of veridical contexts.

1.2 Research questions

This dissertation addresses two general research questions each consisting of several subresearch questions. I will first present the general research questions and then elaborate on them at length.

(9) General research questions:

Q1: What kind of clausal typing mechanism(s) can we find in Mandarin?
Q2: How are wh-interrogatives and wh-existentials licensed in Mandarin?

Research question Q1 originates from the rethinking of traditional clausal typing hypothesis (Cheng, 1991): if Mandarin cannot use wh-movement or particles to type clauses, can prosody function as a clausal typing mechanism? I will address Q1 by investigating the prosodic markings of wh-questions and wh-declaratives, testing listeners’ identification of the two clause types and seeking possible neurocognitive evidence for clausal typing based on prosody (i.e. electrophysiological evidence). Hence Q1 can be divided into three subresearch questions.

(10) Subresearch questions of Q1:

q1: Can wh-questions be differentiated from wh-declaratives through prosody? And if so, how?
q2: Can listeners make use of prosody to recognize the clause type or even anticipate the clause type?
q3: What neural correlates can we find for clausal typing based on prosody?

Subresearch question q1 in (10) aims to understand the role prosody plays in clausal typing by offering a detailed prosodic analysis on the first-hand audio recordings of wh-questions and wh-declaratives. Subresearch question q2 goes further to investigate the role of prosody in clausal typing from the perspective of perception,
namely, whether listeners can detect and anticipate clause types using prosody. Subresearch question q3 aims to build on neurocognitive evidence during real-time language processing for an accurate understanding of the prosodic clausal typing in Mandarin.

Research question Q2 concerns the licensing of Mandarin wh-existentials and wh-interrogatives, which are the two most frequently used interpretations of wh-indeterminates in Mandarin. I can address question Q2 by addressing two subquestions.

(11) Subresearch questions of Q2:

q1: What detailed licensing constraints and evidence can we find in the licensing of wh-existentials?
q2: What processing evidence can we find in the licensing of wh-interrogatives?

Subresearch question q1 in (11) originates from the fact that Mandarin wh-existentials are argued to be licensed only by nonveridical operators (Lin, 1998; Xie, 2007; Lin et al., 2014; Huang, 2017) though counter-examples also exist. We aim to discuss the licensing environments of wh-existentials by investigating the counter-examples. Subresearch question q2 can be addressed based on the evidence of online reading, through which we aim to find evidence for the covert dependency and licensing between the wh-interrogative and the interrogative operator (Q) at Spec-CP or C°.

1.3 Overview of the chapters

This dissertation is organized as follows. Chapters 2, 3 and 6 focus on the clausal typing mechanism of wh-questions and wh-declaratives based on prosody. Chapters 4 and 5 focus on the licensing of wh-interrogatives and wh-existentials respectively. Below I introduce these chapters in this sequence.

Chapter 2 reports a production study on wh-questions and wh-declaratives, which are string identical. By analyzing the acoustic data, we come to understand how prosody is utilized to mark each clause type throughout the sentence, in particular in the pre-wh-word region. This chapter directly answers the subquestion q1 under the general question Q1.

Based on the results of the production experiment in Chapter 2, Chapter 3 reports an audio-perception and an audio-gating study (Grosjean, 1980). The perception study specially investigates whether listeners can differentiate the two clause types, wh-questions and wh-declaratives respectively, by completing a dialogue based on their identification of the wh-questions or wh-declaratives. Instead of a whole sentence as in the perception study, the audio-gating study segments the audios of wh-questions or wh-declaratives into several fragments, i.e., gates, and it specially tests whether listeners can anticipate clause types before hearing the wh-word and if yes, at which part of the sentence or at which gate can the anticipation happen. This chapter directly answers subquestion q2 under the general question Q1.

The perception and gating studies in Chapter 3 are offline studies that help to demonstrate the role of prosody on clause type identification and anticipation. With
respect to the role of prosody in clausal typing during online sentence processing, I seek the direct evidence and neural correlates by conducting two auditory ERP (Event-Related Potentials) studies reported in Chapter 6. These two auditory ERP studies examine wh-questions and wh-declaratives preceded by contexts biasing each clause type and their manipulated conditions. Experiment 1 tests wh-questions and wh-declaratives and their cross-spliced conditions. Audios of wh-questions and wh-declaratives are cross-spliced from the onset of wh-words onwards, in other words, the wh-word and the following constituents from a wh-question audio are spliced and combined to the pre-wh-word constituents of a wh-declarative audio, and vice-versa. It investigates the electrophysiological evidence of clausal typing incongruity. To be specific, when listeners expect a question word, as predicted by the context and the prosody of the pre-wh-word region (Q), they hear a wh-existential from the wh-declarative (D) instead (with a different prosodic marking as compared with the expected one), leading to an incongruent clause type (Q-D). By the same token, when they expect a wh-existential from the wh-declarative, they hear a wh-interrogative from the wh-question instead (D-Q). Experiment 2 manipulates the congruity between the contexts participants hear biasing wh-questions/wh-declaratives and the critical sentences of wh-questions/wh-declaratives participants hear. It investigates whether we can find neural correlates for detecting the early clausal typing incongruity based on prosody already at the subject position of wh-questions/wh-declaratives. The two ERP results directly address subquestion q3 under the general question Q1.

Chapter 4 offers a theoretical discussion on the licensing environments of wh-existentials based on empirical evidence, by focusing on wh-declaratives containing diǎnr ‘a little’ and its licensing on wh-existentials in veridical contexts. This chapter challenges the assumption that the licensing of wh-existentials is restricted in nonveridical contexts (Lin, 1998; Xie, 2007; Huang, 2017) and discusses the role of diǎnr in licensing wh-existentials as well as its detailed constraints in the licensing. Chapter 4 directly answers subquestion q1 under general question Q2.

Chapter 5 investigates the covert licensing of wh-interrogatives by conducting online-reading studies through word-by-word self-paced reading paradigm (Just, Carpenter & Wooley, 1982), which closely resembles natural reading. Different from the other chapters that utilize prosody, this chapter collects pure processing evidence in wh-questions as compared with declaratives with indefinite noun phrase (e.g. ‘a classmate’). The working hypothesis is as follows. If processing a wh-question requires the construction of a covert dependency between the wh-phrase and the interrogative operator (Q) at Spec-CP or C’, the processing cost in wh-questions is thus higher than that in declaratives. Chapter 5 addresses subquestion q2 under general question Q2.

Finally, Chapter 7 concludes the dissertation and summarizes the answers to the research questions posed in this chapter. Since the clausal typing mechanism of Mandarin wh-questions and wh-declaratives is based on prosody, I extend the traditional clausal typing hypothesis of wh-questions (Cheng, 1991) by integrating prosody into it. Furthermore, I summarize the discussions of how wh-interrogatives and wh-existentials are licensed in Mandarin based on all the investigations, as well as its implications for the licensing mechanism of wh-indeterminates cross-linguistically.