



Syntax and Prosody Interface of *Wh*-Scope in Mandarin

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Abstract

This study mainly investigates prosodic strategies to disambiguate the ambiguous *wh*-scope in Mandarin. We also examine the usage of prosodic information in production and perception as well as the relationship between prosody and syntax regarding to *wh*-scope by conducting a series of four experiments.

The results of these experiments show that Mandarin speakers put focused intonation on different lexical items among *wh*-phrases, embedded verbs and matrix verbs according to the *wh*-scope. The mismatch between speakers' encoding and hearers' decoding of prosodic information were also found in these experiments. The prosodic information does not play a crucial role in disambiguating *wh*-scope in perception. In addition, we found that Mandarin speakers use different prosodic strategies depending on the amount of given syntactic information on *wh*-scope. This suggests that syntax affects prosody on *wh*-scope.

Index Terms: *wh*-scope, perception, production, scrambling, prosody, Mandarin

1. Introduction

The relationship between *wh*-scope and *wh*-intonation has been studied in *wh*-in-situ languages such as Japanese and Korean [1, 2, 3, 4, 5, 6, 7]. It is shown that the ambiguity of *wh*-scope as in (1) can be disambiguated by prosody: the F0 pitch compression or high plateau between a *wh*-phrase and an associated complementizer(Q) as in Figure 1.

Bill-un [Mary-ka nwukwu-lul] (1)
Bill-Top Mary-Nom who-Acc
mannassnun-ci] mwulesseo?
Met-Q asked-Q?

Embedded *wh*-scope reading (YNQ):

'Did Bill ask who Mary met?'

Matrix *wh*-scope reading (WHQ):

'Who did Bill ask whether Mary met?'

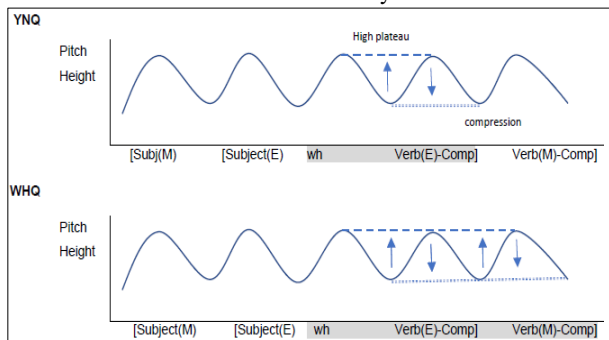


Figure 1: The simplified configuration of *wh*-intonation (F0 compression or high plateau).

The span of *wh*-scope is marked by the domain of deaccented phrases. However, Mandarin Chinese, another *wh*-in-situ language, has different phonological properties from Japanese and Korean; Chinese is a tone language but Japanese and Korean are pitch-accent languages. In Mandarin, since the change of lexical tones directly affects sentence meanings, it is easily predicted that *wh*-scope would not be indicated by the span of tone deletion such as F0 compression or high plateau, contrary to Japanese and Korean. Very few studies, however, have been done on the ambiguity of *wh*-phrases, regarding *wh*-scope in Mandarin (embedded scope vs matrix scope), when *wh*-phrases function simply as interrogative pronouns.

In addition, the displacement of *wh*-phrases which possibly affects processing of *wh*-scope is allowed in Mandarin. The overt syntactic movement of *wh*-phrases such as *wh*-scrambling changes the prosodic phrasing [8]. This change is expected to affect explicitly the prosodic strategy on disambiguation of *wh*-scope in speech.

By focusing on *wh*-scope ambiguity in Mandarin, this study, therefore, aims to investigate the relation between prosody and *wh*-scope in a tone language. In this paper, we also explore the effect of overt syntactic operation on prosody. The specific research questions are as follows:

- In order to disambiguate the ambiguous *wh*-scope as in (2), what kind of prosodic strategies will Mandarin speakers utilize in their production?

Zhenzhi wen-guo [Lisi jian-guo shui]? (2)
Zhenzhi ask-Perf Lisi meet-Perf who

'Did Zhenzhi ask who Lisi met?'

'Who did Zhenzhi ask whether Lisi met?'

- Will the same prosodic strategy in their production be used in their perception? When *wh*-words are scrambled, will the prosody be affected?

In order to answer these questions, we conducted a series of four experiments.

2. Experiments

2.1. Experiment 1: production test

In this section, we will discuss how prosody disambiguates ambiguous sentences such as (2) in Mandarin. In order to investigate what kinds of prosodic strategies Mandarin speakers use to distinguish different *wh*-scopes, we conducted a production test.

2.1.1. Stimuli and procedure

In our stimuli, we controlled three factors. They are the position of *wh*-phrases (subject *vs.* object in an embedded clause), the type of *wh*-phrases regular (*wh*-phrases *vs.* D-linked *wh*-phrases), and the embedded sentence types (default *vs.* A-not-A). In our first experiment, all *wh*-phrases were in an embedded clause only and sentence final particles such as *-ma* and *-ne* were intentionally excluded in order to examine the prosodic effect independently. We created four sets of eight target sentences (= 2×2×2). For each target sentence, we provided two specific contexts leading to different *wh*-scopes (an embedded scope and a matrix scope) as in (3), so a total of 64 target sentences (= 32 sentences × 2 different scopes) were recorded.

“Wang Qiang is a fashion leader and has influenced the fashion trend several times. Last night, your friend saw a TV interview of Wang Qiang by a journalist, Li Hua.” (3)

Embedded scope: Li Hua asked Wang Qiang many questions during the interview. Suppose that you are chatting with your friend now and you want to know which questions Li Hua asked Wang Qiang.

Matrix scope: By watching the interview, your friend learned some fashion trends that Wang Qiang has influenced. Suppose that you are chatting with your friend now and you want to know which fashion trends Wang Qiang has influenced.

Target question:

Lìhuá wèn-guò Wángqiáng yíngxiǎng-guò shénme
Lihua ask-Perf Wangqiang influence-Perf what

Interpretation:

‘Did Lihua ask what Wangqiang has influenced?’ or
‘What did Lihua ask whether Wangqiang has influenced?’

Native Mandarin speakers (N=13) participated in this experiment. They were asked to read each context silently. The proper answer to the target interpretation was also given, in order to prime a specific scope reading. Then, we recorded the target sentences. The participants read the target sentences aloud twice. There was no restriction on number of trials to record the target sentences. The experiment was conducted in the phonetics lab in the department of Linguistics, Stony Brook University. Zoom H6 Handy recorder and Shure SM 48-LC Vocal Dynamic Microphone were used.

2.1.2. Results

As it is expected, each lexical tone was preserved. Contrary to Japanese and Korean, we could not see the tone deletion correlating with the span of *wh*-scope. Thus, following [9] on prosodic effect on different semantic interpretations of *wh*-phrases, regarding interrogative *vs.* *wh*-indefinite in Chinese, we measured the lowest and the highest pitch heights on the embedded verb, the matrix verb and the *wh*-phrase. All collected pitch heights were normalized with Z-score. The gap between the lowest and highest pitches was calculated. The overall average of the pitch excursion is as follows.

Table 1: The overall average of pitch excursion

	Embedded scope	Matrix scope	<i>p</i> -value
<i>Wh</i> -phrase	1.447142	1.612952	< .05
Matrix verb	1.232002	1.195059	> .05
Embedded verb	1.733613	1.751208	> .05

In general, *wh*-phrases are prosodically more focused for the matrix scope reading than for the embedded scope reading (linear regression: $p < .05$), regardless of conditions such as the position of *wh*-phrases in an embedded clause, the type of *wh*-phrases or the embedded sentence types. In addition, even though the differences between two scopes are not significant, there tends to be a bigger pitch excursion on an embedded verb for a matrix scope reading than for an embedded scope reading. These show that Mandarin speakers give a focused intonation to *wh*-phrases and embedded verbs to hint the matrix scope reading. As for an embedded scope reading, a bigger pitch gap is found on a matrix verb, but it is not statistically significant. However, the tendency to put a focus on the matrix verb can be attributed to the effort to give a clear cue for Yes-No questions.

2.2. Experiment 2: perception test

To examine whether the same prosodic strategies used in production are utilized to disambiguate sentence meaning in perception, we conducted a perception test (forced choice task) based on the result of Experiment 1.

2.2.1. Stimuli and procedure

The same stimuli from Experiment 1 were utilized in this experiment. A Mandarin native speaker recorded two versions (embedded *wh*-scope and matrix *wh*-scope) of every target sentence by using prosodic strategies observed in Experiment 1. 64 target sentences intermingled with 112 fillers were distributed across 4 sets in a Latin Square Design. The participants (N=30) were asked to choose one of the given answers as in (3) after listening to the audio file.

Q: Zhenzhui wen-guo Lisi jian-guo shui? (audio) (3)

A: a. Shide (‘yes’) b. Liujun (‘Liujuan’)

In (3), *Shide* (‘yes’) indicates that the question is interpreted as a Yes/No question, which means that the *wh*-phrase has an embedded scope. The other answer *Liujun* indicates that the question is interpreted as a *wh*-question, which means that the *wh*-phrase has a matrix scope reading.

2.2.2. Results

The results are in Table 2. We calculated the percentage of the matrix scope reading. For instance, the 60% in first column means that 60% participants interpreted the target questions as *wh*-questions (matrix scope reading) when the prosodic cue leading to the embedded scope reading was given. For statistical analysis, the logistic linear regression model was utilized. Since a significant difference was not found depending on the positions of *wh*-phrases in an embedded clause, the types of *wh*-phrases or the embedded sentence types, separate results are not provided in Table 2.

Table 2: The results of perception test

	Embedded scope prosodic cue	Matrix scope prosodic cue	<i>p</i> -value
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Matrix scope reading	60%	65%	0.21
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As suggested in Table 2, the prosodic cues shown in the production test do not play a role in disambiguating *wh*-scope ambiguity in Mandarin.

These results show that there is a mismatch between speakers' encoding and hearers' decoding of *wh*-scope information in Mandarin. This is surprising compared to the prosodic effect on *wh*-scope in Japanese and Korean. As a tone language, Chinese is typologically different from Japanese and Korean. The prosodic cues in Japanese and Korean are crucial to distinguish the two *wh*-scope readings because the domain of deaccented phrases exactly matches the range of syntactic and semantic *wh*-scope. Hence, the sentence level prosodic pattern reflecting speakers' intention can help hearers to decide *wh*-scope in Japanese and Korean [7]. In Mandarin, due to the requirement of preservation of lexical tones, the prosody at the sentence level, however, is restrained by the lexical prosody [10]. In sum, there is an asymmetry of disambiguating strategies between production and perception in Mandarin.

2.3. Experiment 3: Comprehension test for *wh*-scrambling

The results of the two previous experiments have shown the role of prosody on *wh*-scope disambiguation when the *wh*-phrases are in-situ. In fact, in addition to prosody, there is another factor which can potentially affect processing of *wh*-scope in Mandarin—namely, *wh*-scrambling. As in (4), *wh*-phrases are allowed to scramble out of their base position.

- a. *wh*-in-situ (4)
 [Matrix ... [Embedded ... ***wh*-phrase** ...]] ?
- b. *wh*-scrambling inside an embedded clause
 [Matrix ... [Embedded ***wh*-phrase**_{*i*} ... *t*_{*i*} ...]] ?
- c. *wh*-scrambling out of an embedded clause
 [Matrix ***wh*-phrase**_{*i*} ... [Embedded ... *t*_{*i*} ...]] ?

Before investigating the relationship between syntactic movement and prosody, we examined whether the changed syntactic positions caused by *wh*-scrambling affect the processing of the semantic scope of *wh*-phrases. For example, when a *wh*-phrase is moved to a syntactically higher position, will there be a preference to the matrix scope reading?

2.3.1. Stimuli and procedure

In order to examine the relation between syntactic positions and *wh*-scope, we controlled for syntactic positions of *wh*-phrases in our stimuli: *wh*-in situ in the embedded clause, the left edge of the embedded clause (SDS: short distance scrambling) and the left edge of the matrix clause. We also used two different types of *wh*-phrases: regular *wh*-phrases (e.g. *what*) and D-linked *wh*-phrases (e.g. *which book*). The two different types of embedded clauses (either default or A-not-A) were also utilized. In this experiment, we fixed the base position of *wh*-phrases into an object position in an embedded clause because the scrambled embedded subject in SDS is not distinguishable from the *wh*-in-situ embedded subject on the surface. We created 4 sets of stimuli; each set consisted of 12 different sentences ($=3 \times 2 \times 2$). We used the eight target sentences of Experiment 1 which have *wh*-phrases in object positions and

then manipulated them according to the three different *wh*-positions.

This experiment consists of a forced choice task. It is conducted through an online survey tool, Qualtrics. In this experiment, the target sentences were presented in the written text, but the same answers used in Experiment 2 were provided. 36 participants were asked to choose one of the given answers after reading the questions.

2.3.2. Results

The scrambling of the *wh*-phrases increased the preference to a matrix scope reading as in Table 3.

Table 3: The results of comprehension test for *wh*-scrambling

	Matrix scope reading	<i>p</i> -value
a. <i>Wh</i> -in-situ	49%	} < .05
b. SDS	76%	
c. LDS	94%	} < .05

The differences between (a) and (b) and between (b) and (c) were statistically significant (logistic linear regression: $p < .05$). The higher the *wh*-phrases were scrambled to, the higher percentage of the matrix scope reading were found. This suggests that syntactic positions of *wh*-phrases have an impact on processing of the semantic scope of *wh*-phrases. In particular, we could see a very strong preference to the matrix scope reading of the *wh*-phrases when it is scrambled to the matrix clause (LDS). That is, the syntactic movement from the embedded clause to the matrix clause resolves the ambiguity of *wh*-scope. Then, how does this overt syntactic movement affect the speech?

2.4. Experiment 4: Production test

The different prosodic patterns were observed depending on *wh*-scopes in Experiment 1. As we have seen in the result of Experiment 3, *wh*-scrambling, however, aids in disambiguating *wh*-scope. Then, will the prosodic strategy be used even in the *wh*-scrambling constructions when the syntactic movement offers a cue to disambiguate *wh*-scope? In order to investigate the relationship between prosody and syntactic movement on *wh*-scope, we conducted the production test.

2.4.1. Stimuli and procedure

The same stimuli from Experiment 3 were utilized in this experiment. However, we excluded the LDS sentences because the result of LDS in Table 3 shows that those sentences are barely interpreted as Yes/No question. For the SDS sentences, the syntactic movement enhances the preference of a matrix scope reading but the ambiguity is not completely resolved there. Hence, we used SDS sentences for the pairwise comparison to *wh*-in-situ sentences. For all target sentences ($32 = 4 \text{ sets} \times 2 \text{ } wh\text{-positions} \times 2 \text{ } wh\text{-types} \times 2 \text{ embedded sentence types}$), we provided the two specific contexts leading to the different *wh*-scopes (an embedded scope and a matrix scope), so total 64 target sentences were recorded. Six Mandarin native speakers participated in this experiment. The participants were asked to read the target sentences aloud after reading the given contexts. There was no restriction to record the target sentences more than twice if the participants requested to do so.

2.4.2. Results

We measured the lowest and the highest pitch heights on the embedded verb, the matrix verb and the *wh*-phrase. All collected pitch heights were normalized with Z-score. The gap between the lowest and highest pitches was calculated. The overall average of the pitch excursion is as follows.

Table 4: *The overall average of pitch excursion*

	<i>Wh-in-situ</i>		<i>SDS</i>	
	Emb	Mat	Emb	Mat
<i>Wh</i> -phrase	1.490	1.652	1.578	1.559
Matrix verb	0.826	0.848	0.929	0.912
Embedded verb	1.416	1.472	1.604	1.241

As in Table 4, *wh*-phrases are prosodically more focused for the matrix scope reading than for the embedded scope reading in *wh*-in-situ constructions; same as what we found in Experiment 1. In *SDS* constructions, the embedded verbs are more focused for the embedded scope reading. These show that giving a focused intonation to *wh*-phrases is the main strategy to indicate the matrix scope reading for *wh*-in-situ constructions. However, *wh*-phrases were not prosodically focused in *wh*-scrambling constructions. Under the economy view, since the *wh*-scrambling already informs the matrix scope readings, Prosodically put focus intonation on *wh*-phrases in *SDS* constructions might be redundant. Interestingly we found that there was an effort to hint the embedded scope reading of *wh*-phrases in *SDS* constructions; the embedded verbs in *SDS* constructions, which happens to be in the sentence final position, were prosodically more focused by a strong raising tone for the embedded scope reading than for the matrix scope reading. Since the matrix scope reading in *SDS* constructions is far more preferred as in the results of Experiment 3, we conjecture that Mandarin speakers add the prosodic information leading to the embedded scope reading.

In sum, the results show the effect of syntax on prosody. Mandarin speakers use different prosodic strategies to disambiguate the *wh*-scope depending on the positions of *wh*-phrases.

3. Discussion

This study mainly investigated the relationship between prosody and *wh*-scope in Mandarin and the effect of syntax on prosody.

Our first experiment shows that speakers tend to give a focused intonation to *wh*-phrases embedded verbs to hint the matrix scope reading, but a bigger pitch gap on matrix verbs was found for the embedded scope reading. Also, we could see that these prosodic strategies are not used in their perception through the second experiment. The focus information for each scope is not strong enough to disambiguate the *wh*-scope in the perception. In other words, when the prosodic information is not categorical, it does not play a decisive role to disambiguate *wh*-scope in the perception.

In addition, we could see the effect of syntax on prosody through the third and the fourth experiments. Overt syntactic movement of *wh*-phrases induced the preference to the matrix scope reading. In the scrambled constructions, *wh*-phrases were not more explicitly focused for the matrix scope reading than for the embedded scope reading. Instead, the embedded verbs

are more focused for the embedded scope reading because of the word order in the *wh*-scrambling constructions.

In conclusion, there is a mismatch between speakers' encoding and hearers' decoding of prosodic information regarding to *wh*-scope in Mandarin. The syntactic difference triggered by scrambling brings about the different prosodic strategies in speech.

4. References

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