

## Prosody and *Wh*-scope Interpretation in Chinese

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This study shows that in Mandarin Chinese, there exists *wh*-scope ambiguity in the construction, which has been widely claimed as a typical example of *wh*-island effect in *wh*-in-situ languages. In addition, this study confirms that the *wh*-scope ambiguity can be prosodically disambiguated in people's speech. In general, the big pitch excursion on *wh*-phrases is found for matrix scope reading of *wh*-phrases. The specific phonological strategies on an embedded verb and a matrix verb are different depending on the embedded clause type and *wh*-phrase type.

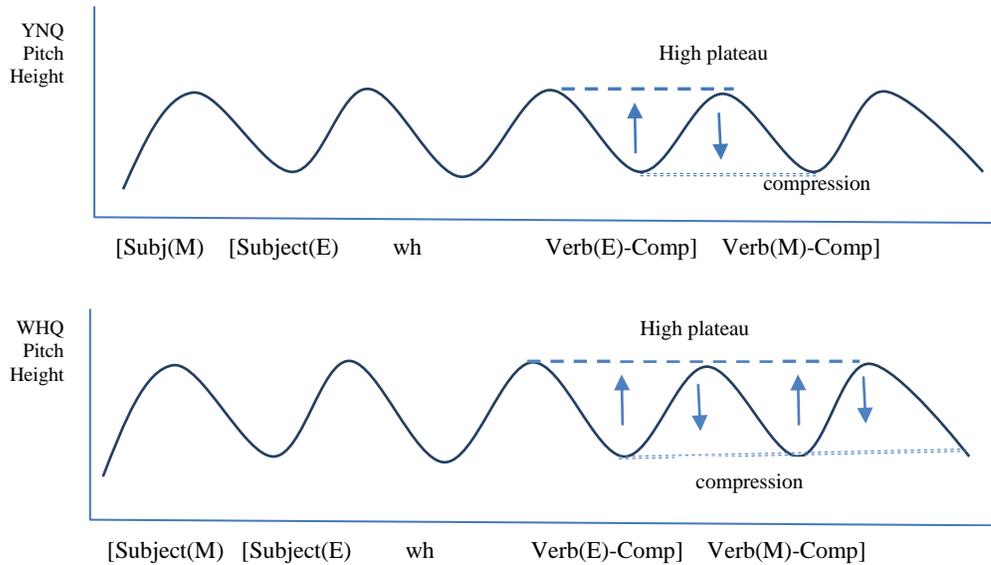
### 1. Introduction

The *wh*-island effect at LF in *wh*-in-situ languages has drawn a lot attention in many studies. Recent studies including Ishihara (2002) and Hwang (2011) claim that the interpretation of the *wh*-phrases in (1) is ambiguous between an embedded scope (YNQ) (1a) and a matrix scope (WHQ) (1b) in Japanese and Korean.

- |             |          |  |                |                     |                |
|-------------|----------|--|----------------|---------------------|----------------|
| (1) John-un | [Mary-ka | nwukwu-lul                             | mannassnun-ci] | mwuless-eo?[Korean] |                |
|             | John-Top | [Mary-Nom                              | who-Acc        | met-Q]              | asked-Q?       |
|             | a.       | 'Did John ask who Mary met t?'         |                |                     | Embedded scope |
|             | b.       | 'Who did John ask whether Mary met t?' |                |                     | Matrix scope   |

According to them, the semantic scope ambiguity of the *wh*-phrases in (1) can be disambiguated by prosody. The F0 pitch compression or high plateau appears between a *wh*-phrase and an associated complementizer as in (2). In other words, *wh*-scope is indicated by the span of F0 pitch compression or high plateau in Japanese and Korean.

(2) The simplified configuration of F0 pitch compression and high plateau



Then, similar to Japanese and Korean, will sentences like (3) in Chinese also allow both scope readings listed?

- (3) Zhengzhi wen-guo Lisi jian-guo shui?  
 Zhengzhi ask-Perf Lisi meet-Perf who  
 a. 'Did Zhengzhi ask who Lisi met?' Embedded scope  
 b. 'Who did Zhengzhi ask whether Lisi met?' Matrix scope

If so, will prosody disambiguate *wh*-scope interpretation? And what kind of prosodic strategy will be used? In order to investigate the relation between *wh*-scope and prosody in Chinese, we conducted two experiments.

## 2. Experiment 1

We examined the existence of the scope ambiguity of *wh*-phrases in an embedded clause as in (3) by conducting experiment 1. This experiment consisted of a forced choice task and an acceptability judgment task. 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). We created four sets of eight target sentences (= 2×2×2). Total 32 target sentences intermingled with 192 fillers were distributed across four sets in a Latin Square Design in the experiment.

71 native Chinese speakers participated in this experiment. For the forced choice task, participants were asked to choose one of the two given answers as in (4) after reading the question.

- (4) Question: Zhengzhi wen-guo Lisi jian-guo shui?  
 Answer: a. Shide('Yes')      b. Liujun('Liujun')

In order to avoid being misinterpreted as declaratives, the question marker always appeared at the end of sentence. After the forced choice task, we examined the acceptability of matrix scope reading which violates a *wh*-island constraint. In the acceptability judgment task, the participants rated the naturalness of a question and answer pair on a 7-point scale; 0 means the least natural and 6 means the most natural. In a question and answer pair, the possible answer to only *wh*-question as in (4b) was provided as in (5).

- (5) Question: Zhengzhi wen-guo Lisi jian-guo shui?  
 Answer: Liujun('Liujun')

0 (The least natural)      1      2      3      4      5      6 (The most natural)

The results of a forced choice task and an acceptability are as follows.

(6)

	The type of <i>wh</i> -phrases	Position	A-not-A	Forced Choice result (Matrix scope answer)	Acceptability judgment result (Max: 6)
1	Regular <i>wh</i>	Subject	No	50 %	3.1
2	Regular <i>wh</i>	Subject	Yes	57%	2.9
3	Regular <i>wh</i>	Object	No	52%	3.2
4	Regular <i>wh</i>	Object	Yes	45%	2.9
5	D-linking <i>wh</i>	Subject	No	43%	3.1
6	D-linking <i>wh</i>	Subject	Yes	43%	3.1
7	D-linking <i>wh</i>	Object	No	42%	3.5
8	D-linking <i>wh</i>	Object	Yes	35%	2.7

The results of the forced choice task show that there exists scope ambiguity in Chinese as well. The overall result of matrix scope answers in the forced choice task reached to around 50%, which means half of participants interpreted the question as a *wh*-question but the others interpreted the questions as a Yes-No question. No significant difference depending on the position of *wh*-phrases (subject *vs.* object) was found

(logistic regression model:  $p > .05$ ). The embedded sentence type (default vs. A-not-A) did not play a crucial role to decide the *wh*-scope either. However, as shown in (6), the results of type 5 to 8 are relatively lower than the ones of types 1 to 4. This shows that embedded scope reading for D-linked *wh*-phrases is preferred (logistic regression model:  $p < .05$ ).

Now let us take a look at the result of the acceptability judgment task in (6). The results on the matrix scope reading reached around 3. The difference between the conditions is not significant (linear regression model:  $p > .05$ ,  $t < 2$ ). This suggests that the matrix scope reading of *wh*-phrases can be accepted as natural regardless of the conditions. One might wonder why 3 can be assumed to be natural one, even though it is the midpoint of the scale. According to Lee and Yun (2016), since the sentence structures are not common in the colloquial conversation, the result of acceptability judgment task with 7-point scale in their study also reached around 3 out of 6 even with proper prosodic cues and morphological cues leading to matrix scope reading. Based on this, we assumed that 3 means acceptable.

In sum, the results from both a forced choice task and an acceptability task show that there exists *wh*-scope ambiguity in Chinese. Considering that the tasks in our experiment did not provide any other linguistic cues such as intonations and morphological markers which presumably affect processing *wh*-scope, the results further suggests that there is no *wh*-island effect at LF in Chinese.

### 3. Experiment 2

In this section, we will discuss how prosody disambiguates the ambiguous sentences proved in Experiment 1. In order to investigate what kinds of prosodic strategies Chinese speakers use to distinguish different *wh*-scopes, we conducted the production test. The same target sentences in Experiment 1 were utilized. The specific contexts leading to the different *wh*-scopes (an embedded scope and a matrix scope) were given as in (7), so total 64 target sentences (= 32 sentences  $\times$  2 different scopes) were recorded.

- (7) “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.”

**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.

Q: Lihua wen-guo Wangqiang yingxiang-guo shenme?  
 Lihua ask-Perf Wangqiang influence-Perf what  
 ‘Did Lihua ask what Wangqiang has influenced?’/  
 ‘What did Lihua ask whether Wangqiang has influenced?’

15 native Chinese speakers participated in this experiment. They were asked to read each context silently. The proper answer to the target question was also given, in order to prime a specific scope reading. Then, they read the target sentence aloud. The target sentences were recorded twice. There was no restriction to record the target sentences more than twice if the participants asked to do it. 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.

We analyzed the data from 14 participants excluding one participant because of the creaky voice. 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.

(8)

	Embedded scope	Matrix scope	<i>p</i> -value
Matrix Verb	1.232002	1.195059	> .05
Embedded Verb	1.733613	1.751208	> .05
<i>Wh</i> -phrase (subject or object)	1.447142	1.612952	< .05

In general, *wh*-phrases are prosodically more focused for the matrix scope reading than for the embedded scope reading. In addition, even though the differences between two scopes are not significant, there tends to be the bigger pitch excursion on an embedded verb for a matrix scope reading than for an embedded scope reading. These show that Chinese speakers give a focused intonation to *wh*-phrases and embedded verbs to hint the matrix scope reading. As for an embedded scope reading, the bigger pitch gap tends to be 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 question.

Now let us take a look at each result of the measured points in detail. Note that either a significant difference or a pattern according to the syntactic position of *wh*-phrases (subject vs. object) was not found so its specific result will not be provided here. First, the average of the pitch excursion on *wh*-phrases is in (9).

(9)

<i>Wh-type</i>	<i>A-not-A</i>	<i>Embedded Scope</i>	<i>Matrix scope</i>	<i>p-value</i>
D-linked <i>wh</i>	No	1.918692	2.020285	< .05
Regular <i>wh</i>	No	1.257796	1.400369	
D-linked <i>wh</i>	Yes	1.604984	1.818547	
Regular <i>wh</i>	Yes	1.016003	1.222323	

As in (9), *wh*-phrases were prosodically focused for the matrix scope reading (linear regression:  $p < .05$ ,  $t = 5.03$ ,  $df = 879.09$ ) regardless of syntactic conditions. It is conjectured that the speakers give the cues for the matrix scope reading to the hearers by making the *wh*-phrase acoustically salient. This tendency was also found in Japanese and Korean (Hwang 2011).

Next, the results on another measuring point, the matrix verbs, are in (10). In overall result, we found that the matrix verb is focused for an embedded scope reading shown in (8). However, two different patterns are observed on matrix verbs depending on the presence of A-not A construction.

(10)

<i>Wh-type</i>	<i>A-not-A</i>	<i>Embedded Scope</i>	<i>Matrix scope</i>	<i>p-value</i>
D-linked <i>wh</i>	No	1.270386	1.151225	< .05
Regular <i>wh</i>	No	1.338576	1.195081	
D-linked <i>wh</i>	Yes	1.231659	1.255531	> .05
Regular <i>wh</i>	Yes	1.204188	1.240146	

The matrix verbs were focused for embedded scope reading in default constructions, but they were focused for matrix scope reading in A-not-A constructions. The difference between for embedded scope reading and for matrix scope reading was significant when the embedded sentences were default constructions. This shows that when the embedded sentence is structurally marked as a question, the prosodic strategy can be optional. In other words, prosody plays a crucial role on deciding the *wh*-scope when the syntactic structure does not offer additional information.

At last, the pitch excursion on an embedded verb is as follows.

(11)

<i>Wh</i> -type	A-not-A	Embedded Scope	Matrix scope	<i>p</i> -value
D-linked <i>wh</i>	No	1.436072	1.369298	> .05
D-linked <i>wh</i>	Yes	2.027558	1.992079	
Regular <i>wh</i>	No	1.413712	1.611547	> .05
Regular <i>wh</i>	Yes	2.014911	2.023553	

Two different patterns were also found on embedded verbs depending on the type of *wh*-phrases, even though the difference between embedded scope reading and matrix scope reading was not significant. When the *wh*-phrases are D-linked *wh*-phrases such as “which book” or “which food”, the bigger pitch excursion was found on embedded verbs for embedded scope reading. However, it was found for matrix scope reading when regular *wh*-phrases were included. This shows that the *wh*-type can potentially have an impact on processing *wh*-scope in Chinese.

#### 4. Discussion

Prosodic effect on different semantic interpretations of *wh*-phrases, regarding interrogative *vs.* *wh*-indefinite in Chinese has been studied, as in Hu (2002). Few studies, however, have been done on the ambiguity of *wh*-phrases, regarding matrix scope *vs.* embedded scope in Chinese, when *wh*-phrases function simply as interrogative pronouns. In that sense, this study is meaningful to reveal the relation between prosody and *wh*-scope ambiguity.

Through two different experiments, this study confirms that there is *wh*-scope ambiguity in Chinese similar to Japanese and Korean. In addition, we found that the Chinese speakers use the specific prosodic strategy to disambiguate the semantic scope ambiguity of *wh*-phrases. However, the scope is not marked by the span of F0 pitch compression or high plateau, contrary to Japanese and Korean. Instead, the biggest pitch excursion was found always on the *wh*-phrase for the matrix scope reading, and found sometimes on matrix verbs and embedded verbs contingent upon syntactic structure and *wh*-phrase type.

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