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CHILDREN'S USE OF PROSODY IN RESOLVING A SYNTACTIC AMBIGUITY ASSOCIATED WITH *ONLY*: EVIDENCE FROM MANDARIN*

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ABSTRACT

This study examined the age at which Mandarin-speaking children can resolve a syntactic ambiguity associated with the focus particle *zhi* 'only' in an adult-like way by means of prosody. It tested eight age groups, from three-year-olds to ten-year-olds, by having the children perform a picture-choice task. They were asked to identify the picture that correctly illustrated the intended meaning of an ambiguous sentence served by prosody. Results showed that the NP closer to the focus particle was resolved earlier, likely due to proximity or limited working memory. Furthermore, this type of ambiguity exhibited a very late acquired phenomenon: only ten-year-olds showed an adult-like performance in the resolution of the ambiguity. The results of this study support the view (Singh and Fu 2016) that, due to the interaction between tone and intonation, a tone language is acquired more slowly than a non-tone language.

Key words: prosodic resolution, syntactic ambiguity, children, Mandarin

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1. INTRODUCTION

Prosody expresses a variety of linguistic functions (Xu 2005). Some of these functions are the distinction of lexical categories (e.g. *record* /rɪˈkɔrd/ vs. *record* /ˈrɛkərd/) by stress (Donselaar et al. 2005; Liberman 1975), the distinction of homophonous words (e.g. *mā* 'mom' vs. *má* 'hemp') by tone (Chao 1968; Wang and Lee 2015; Xu 1997), highlighting an important part of a sentence by prominence (Ladd 1984; Xu and Xu 2005), and categorizing an utterance as a statement or a question by intonation (Ladd 1981). Another crucial linguistic function that prosody performs is the resolution of syntactic ambiguity (Hirschberg and Avesani 2000; Lee 2012; Zhou et al. 2012), as shown in (1) (Zhou et al. 2012:696).

(1) Zhiyou Xiaoming de naozhong shi huangsede.
only Xiaoming DE clock is yellow
'Only Xiaoming's clock is yellow.'
(a) Xiaoming's clock is yellow; nothing else (in the discourse context) is yellow.
(b) Xiaoming's clock is yellow; no one else's clock (in the discourse context) is yellow.

Sentence (1) has two possible meanings depending on where prominence is placed. When prominence falls on *naozhong* ('clock') the sentence means (1a), whereas when prominence falls on *Xiaoming*, it means (1b).

Given the important linguistic functions served by prosody, many studies have examined sensitivity to prosody for both children and adults. Such studies have attested that, compared to adults, children have a lower capacity for decoding linguistic functions through prosody (e.g. Carlson et al. 2001; Choi and Mazuka 2003; Cutler and Swinney 1987; Zhou et al. 2012). Through numerous instances documenting various aspects of prosody relative to children's comprehension, a paradox has been identified between prosodic comprehension and its production; the former is acquired later than the latter in certain cases (e.g. Cutler and Swinney 1987; Zhou et al. 2012). For example, children who could reliably distinguish *black bird* from *blackbird* by stress had difficulty

perceiving the difference in comprehension (Atkinson-King 1973). A similar finding was reported in Hornby's (1971) study: children were able to make a distinction between old and new information in production, but showed poor performance for the same task in comprehension. A further line of research revealed similar findings in comprehension. Three- and four-year-olds did not perform well in responding to stressed pronouns (Maratsos 1973); even older children, aged five to seven, had similar difficulties with the reference of stressed pronouns (Solan 1980). In addition, Cruttenden (1974) demonstrated that children between the ages of seven and ten required further development in fully distinguishing the role of intonation patterns that produced different meanings.

There have also been many attempts to examine whether children can successfully use prosody in resolving ambiguous sentences in many languages (e.g. English: Halbert et al. 1995; German: Hüttner et al. 2004; Mandarin: Zhou et al. 2012). Among these, Zhou et al. reported an interesting, significant finding—that the acquisition of prosody for the resolution of ambiguity varied depending on the type of ambiguity. In their study, two types of ambiguity—speech act vs. syntactic—were examined to test which ambiguity type is resolved earlier by prosody. For speech act ambiguity, as exemplified in (2), a negative sentence with a *wh*-word was used since it can be used as either a statement or a question depending on the type of intonation contour (Zhou et al. 2012:712).

(2) Yuehan meiyou chi shenme shuiguo.
John not eat what fruit
a. What kind of fruit didn't John eat?
b. John didn't eat any fruit.

When the *wh*-phrase *shenme shuiguo* 'what fruit' is spoken with a rising intonation, it means (2a); with a level intonation, it means (2b). The main finding of this task demonstrated that four- to five-year-old Mandarin children can distinguish between the two interpretations by means of prosody. Next, two different tasks (a judgment task and an eye-tracking task) were conducted for the syntactic ambiguity using a sentence like (1)

above. The result of the judgment task showed that four- to five-year-olds were not able to resolve a syntactic ambiguity by prosody. From the two interpretations of (1), they tended to select interpretation (1b) due to limited working memory capacity regardless of the placement of prominence within the sentence. The result of the eye-tracking task was that, although the children in the study were sensitive to prosodic cues that resolve the syntactic ambiguity, they had a delayed effect on the resolution of the syntactic ambiguity when compared to adults. In a nutshell, the important message of Zhou et al.'s (2012) study is that the acquisition period for prosody varies by the type of ambiguity.

Another factor might delay the acquisition period for prosody in resolving ambiguity. Singh and Fu (2016) propose that a tone language is more difficult to acquire than a non-tone language, because tone language learners need to acquire both a lexical tone system and an intonational structure. For example, Mandarin has four lexical tones: a high level tone (tone 1), a rising tone (tone 2), a low/dipping tone (tone 3), and a falling tone (tone 4). Depending on the pitch level, the four tones are classified as [55], [35], [214], and [51]. In this classification, [1] is the lowest pitch and [5] the highest (Chao 1968). When these tones are spoken in isolation, the pitch of each tone is shown to be fairly stable (Chao 1968; Xu 1997). However, when spoken within a sentence, these tones show variations (Shen 1990; Xu 1994). Additionally, tone language learners must understand the difference in intonation patterns that is produced at the sentence level. Therefore, since tone language learners must understand the interactions between lexical tone and intonation that are mainly caused by manipulating pitch events, it is reasonable to speculate that tone language learners are slower in their resolution of an ambiguity than non-tone language learners by means of prosody.

1.1 Setting the Stage

From a literature review, we can formulate two generalizations. First, different types of ambiguity are resolved differently by prosody: the resolution of a syntactic ambiguity seems quite late. Next, the acquisition period for prosody in resolving ambiguity seems slower in a tone-

language, due to the interaction between tone and intonation. Although several studies have already examined the resolution of a syntactic ambiguity associated with *only*, there is still an important question to be addressed: at what age can children speaking a tone language show an adult-like performance in resolving an ambiguity associated with *only*? Although Zhou et al.'s (2012) study revealed an interesting finding about the resolution of ambiguity associated with *only* in Mandarin, clear evidence still remains to be provided to estimate the age at which children speaking a tone-language can resolve the syntactic ambiguity associated with *only* in an adult-like manner. Given the two generalizations, we can make two hypotheses. One is that the child participants will show a very late acquired phenomenon in resolving an ambiguous sentence with *only*. The other is that children's performance may differ by the placement of prominence within a sentence. Due to children's limited working memory, as found in Zhou et al. (2012), the NP closer to the focus particle *only* (i.e. proximity) will be resolved earlier. We tested these hypotheses by conducting a picture-choice task, through which participants identified the situation that correctly described the intended meaning of an ambiguous sentence associated with *only* by prosody.

2. METHOD

2.1 Participants

Since this study aimed to estimate the age at which children can resolve the syntactic ambiguity associated with the focus particle *zhi* 'only' in an adult-like manner, child participants of the same age were grouped together, but the upper age limit was not established before the experiment began. This was because we attempted to find children whose performance was comparable to that of adults. The experiment started with three-year-olds and moved to ten-year-olds who appeared to behave in an adult-like manner. In this study, a three-year-old was classified as a child aged anywhere between 3;0 and 3;12 and the remaining age groups were also classified accordingly (see Table 1). A

total of 108 children were recruited and grouped by age. Of these, 36 children were recruited from a community kindergarten in Liaocheng, a city of Shandong Province in China, and 60 children from an elementary school of Liaocheng University. In addition, 12 college students from Liaocheng University were recruited and tested for comparison purposes. Table 1 shows the number of participants, the age range and the mean age of each age group. The mean age was calculated at the time of the experiment.

Table 1. Number of participants, age range, and mean age in each age group

Age group	Participants	Age range	Mean Age
3-year-olds	12 (5 boys, 7 girls)	3;0-3;12	3;8
4-year-olds	12 (4 boys, 8 girls)	4;0-4;12	4;6
5-year-olds	12 (6 boys, 6 girls)	5;0-5;12	5;9
6-year-olds	12 (6 boys, 6 girls)	6;0-6;12	6;9
7-year-olds	12 (5 boys, 7 girls)	7;0-7;12	7;7
8-year-olds	12 (6 boys, 6 girls)	8;0-8;12	8;7
9-year-olds	12 (5 boys, 7 girls)	9;0-9;12	9;8
10-year-olds	12 (4 boys, 8 girls)	10;0-10;12	10;7
Adults	12 (2 males, 10 females)	21-22	21;4

2.2 Test Stimuli

Test stimuli were constructed with a double object construction (DOC) that included a focus particle *zhi* 'only' as shown in (3). The structure produces two different meanings depending on the association of *zhi* 'only' with either a direct object (DO) or an indirect object (IO). If *zhi* 'only' is associated with the IO *Xiaohong*, the meaning of the sentence is that Xiaoming gave an ice cream only to Xiaohong, and no one else. If the focus particle is associated with the DO *bingqilin* 'ice cream', then the meaning of the sentence is that Xiaoming gave only an ice cream, and nothing else, to Xiaohong. As noted before, this type of

ambiguity can be resolved by prominence within a sentence. In Mandarin, the acoustic correlates of prominence are known to accompany a combination of a longer duration, greater intensity, and a more expanded pitch range (e.g. Lee et al. 2016; Lee 2015; Shih 1988; Xu 1999).

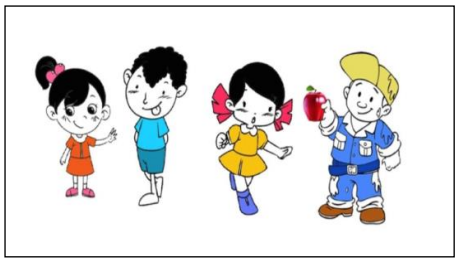
(3) 小明只送给小紅一個冰淇淋。
Xiaoming zhi songgei Xiaohong yi ge bingqilin.
Xiaoming only give Xiaohong one CL ice cream
'Xiaoming only gave Xiaohong an ice cream.'

The experiment included six test sentences with the focus particle *zhi* 'only', and containing a ditransitive verb *songgei* 'give' or *gei* 'give', each of which leads to two interpretations depending on whether prominence falls on a DO or an IO in a sentence. Therefore, this study comprised a total of 12 test sentences with some filler sentences to mask the test stimuli (See Appendix for details).

In order to facilitate children's participation, test stimuli were always accompanied by three different pictures as a measure of comprehension (see Figure 1). Each picture depicted two characters: Xiaoming (a boy) and Xiaohong (a girl). Referring to the description of each figure, Figure 1a illustrates a situation in which Xiaoming gave only Xiaohong, and no one else, an apple, and Xiaohong is contrasted with other characters. Figure 1b depicts a situation in which Xiaoming gave only an apple, and nothing else, to Xiaohong, in which an apple contrasts with other items, such as bananas, a rubber duck, and a gift box. In the situation depicted in Figure 1c, Xiaoming gave Xiaohong an apple, in which a test sentence lacks a meaning of *only*.[1]

[1] There are three reasons for the inclusion of this picture. The first reason is to lower the chance level from 50% to 33.3%. Second, we must identify whether or not child participants can acquire the meaning of contrastiveness. Without the picture like Figure 1c, it is uncertain whether child participants' choice was driven by the meaning of contrastiveness or by the action of providing an apple. Finally, the inclusion of the picture may enable us to control for participants' potential preferential choice which could affect the credibility of the experiment's results.

a.



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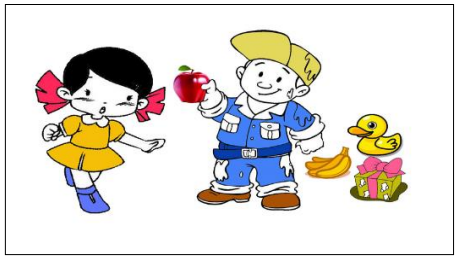

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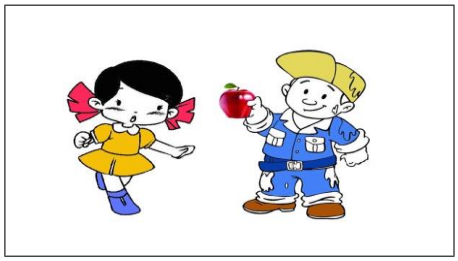

Figure 1. Sample picture prompts used in the perception experiment.

2.3 Stimuli Recordings

We invited a female television announcer to give an audiovisual presentation of the stimuli. Test and filler sentences were recorded in a soundproof booth at Liaocheng TV Station, Shandong Province. She was instructed to record the stimuli for the purpose of child-directed speech. Each test sentence was produced in two versions: one with prominence on an IO, and the other with prominence on a DO. As previously stated,

prominence was realized by the concomitant increased duration, intensity, and pitch range (maximum minus minimum pitch). Figure 2 presents the two versions of prominence depending on where *zhi* 'only' is associated within a sentence: Figure 2a shows prominence on an IO; Figure 2b shows prominence on a DO.

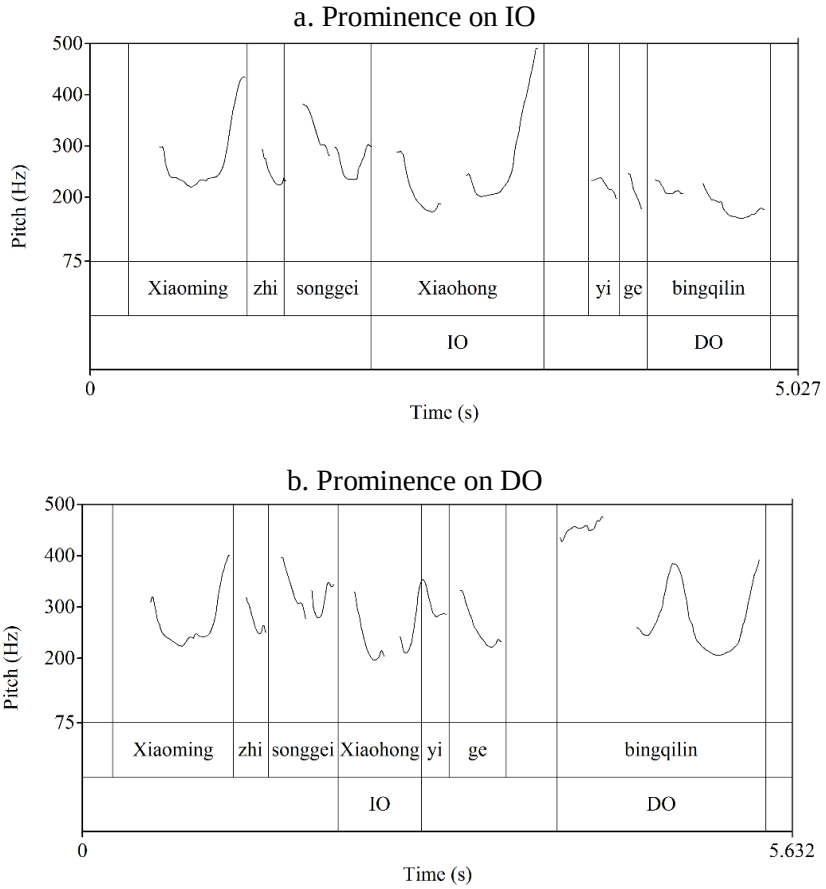

Figure 2. Two versions of prominence associated with *zhi* 'only' in a sentence '*Xiaoming zhi songgei Xiaohong yi ge bingqilin/Xiaoming gave Xiaohong an ice cream*.'

Table 2 tabulates the pitch range, duration, and mean intensity, stratified by prominence conditions. Please note that each acoustic value was calculated by the aggregate measures taken from all the test stimuli.

Table 2. Aggregate measures of the pitch range, duration, and mean intensity, stratified by prominence conditions. (Cells shaded in gray represent target acoustic values.)

Prominence condition	Acoustic parameters	IO	DO
Prominence on IO	Pitch range (Hz)	203.8	88.9
	Duration (ms)	1262.4	853.8
	Mean intensity (dB)	78.9	70.2
Prominence on DO	Pitch range (Hz)	172.0	212.3
	Duration (ms)	754.4	1445.7
	Mean intensity (dB)	75.5	79.7

2.4 Experiment Procedure

A total of 24 sentences (12 test and 12 filler) were divided into six blocks and were arrayed in a Latin square design, through which we placed different sentences with different prominence conditions, as illustrated in Table 3.[2] For example, the first block (B1) of Set 1 consists of four items labelled S1a, F1, S2b, and F2. S1 and S2 refer to target sentences; a lower-case letter (a, b) denotes a prominence condition; and F1 and F2 indicate filler sentences. Note that in each set, the first block begins with the second block of the previous set. This design enabled us to counterbalance the order of tasks to reduce the chances of the order affecting results and to minimize the effect of stimulus familiarity by placing fillers between target sentences.

[2] One of the reviewers pointed out that since the target sentences, prominence conditions, and filler sentences always appeared in the same order across all the blocks in each set, the stimuli design would exert some degree of influence over the learning effects of participants. We agree with the reviewer's comment and note this as one of the limitations in our study.

Table 3. A Latin square design of the current study

Set 1		Set 2		Set 3		Set 4		Set 5		Set 6	
B1	S1a F1 S2b F2	B2	S3a F3 S4b F4	B3	S5a F5 S6b F6	B4	S1b F7 S2a F8	B5	S3b F9 S4a F10	B6	S5b F11 S6a F12
B2	S3a F3 S4b F4	B3	S5a F5 S6b F6	B4	S1b F7 S2a F8	B5	S3b F9 S4a F10	B6	S5b F11 S6a F12	B1	S1a F1 S2b F2
B3	S5a F5 S6b F6	B4	S1b F7 S2a F8	B5	S3b F9 S4a F10	B6	S5b F11 S6a F12	B1	S1a F1 S2b F2	B2	S3a F3 S4b F4
B4	S1b F7 S2a F8	B5	S3b F9 S4a F10	B6	S5b F11 S6a F12	B1	S1a F1 S2b F2	B2	S3a F3 S4b F4	B3	S5a F5 S6b F6
B5	S3b F9 S4a F10	B6	S5b F11 S6a F12	B1	S1a F1 S2b F2	B2	S3a F3 S4b F4	B3	S5a F5 S6b F6	B4	S1b F7 S2a F8
B6	S5b F11 S6a F12	B1	S1a F1 S2b F2	B2	S3a F3 S4b F4	B3	S5a F5 S6b F6	B4	S1b F7 S2a F8	B5	S3b F9 S4a F10

The experiment was conducted using PowerPoint slides. Prior to the actual experiment, a practice test with three test trials was given to listeners in order to familiarize them with the procedure. Based on the Latin square design, the first set of six blocks was given to the first participant and the next set of six blocks was given to the next participant, in order of precedence. During the experiment, participants listened to each stimulus carefully and selected the intended interpretation of the sentence using a three-picture choice task. Both child and adult participants were instructed to choose an appropriate picture, and then the experimenter recorded the answer on an answer sheet. The experiment lasted about 15-20 minutes for each listener.

2.5 Statistics

A logistic regression analysis, through the *lmerTest* package (Kuznetsova et al. 2013) in R (R Core Team 2016), was carried out for statistical analysis. In this regression model, age (three through adult) and prominence condition (IO and DO) were included as fixed effects, listener and item as random effects, and identification as a dependent variable. The *Anova* function of the *lmerTest* package was used to determine whether fixed effects were significant. For a multiple compassion (Tukey) analysis, the *mcp* function from the *lmerTest* package was implemented for the main effect of age in determining which pair was significantly different between age groups.

3. RESULTS

Figure 3 compares the identification rates (y-axis) between age groups (x-axis) depending on the prominence conditions (IO and DO) in a sentence. In this figure, the points represent mean identification rates (in percentages) and the areas shaded in gray indicate 95% confidence intervals. Overall, the mean identification rate increased proportionally with age for both prominence conditions. Before presenting the main results of the study, we need to consider if child participants' identification rates differ significantly by the main effect of prominence condition. Unless significant differences emerge, we will collapse the two prominence conditions for further analyses.

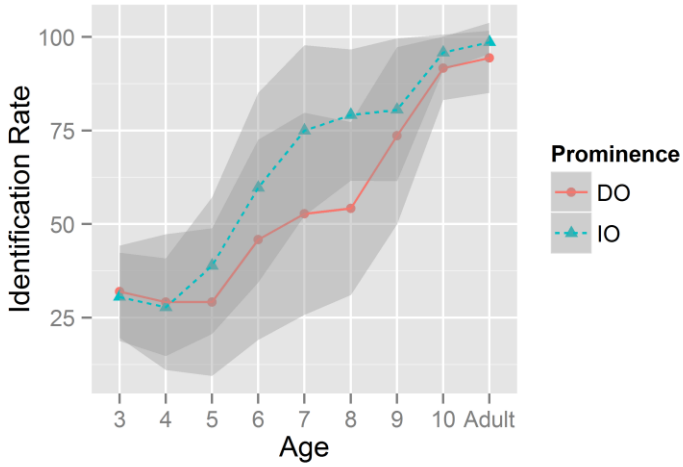

Figure 3. The identification rates between different age groups.

The result of the logistic regression analysis showed that the main effect of prominence condition on identification was highly significant (X^2 = 13.63, df = 1, p < 0.001). Furthermore, the interaction between age and prominence condition showed a significant effect on identification (X^2 = 398.7, df = 17, p < 0.001). The results suggest that participants performed differently depending on the placement of prominence conditions in a sentence. The results lead us to split the prominence conditions and analyze the results; we first present the results for the IO prominence condition, followed by an analysis of the DO prominence condition.

As illustrated in Figure 4a, children aged three to five showed similar identification rates between 27.8% and 38.9%, which is below or just above the random chance level (100/3 = 33.3%) performed in our experiment. Six-year-olds performed better (about 59.7%) than younger children. Children aged seven to nine produced similar identification rates between 75.0% and 80.6%. Ten-year-olds showed an increased identification rate of 96.8%, a performance comparable to that of adults.

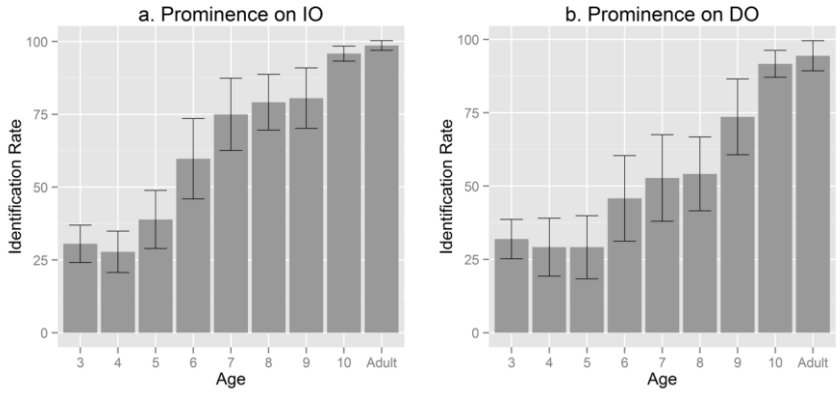

Figure 4. Identification rates between different age groups stratified by prominence conditions. (Error bars refer to 95% confidence intervals.)

For the IO prominence condition, the result of the logistic regression revealed that the main effect of age on identification turned out to be highly significant (X^2 = 214.95, df = 8, p < 0.001). A multiple comparison analysis was thus performed to examine which pair was significantly different between age groups. For simplicity's sake, to save space and to avoid less important outcomes of the multiple comparison analysis, we have omitted data that compared all possible combinations of age groups. We present only the data comparing an adult group to each available age group, as shown in Table 4.

Table 4. Multiple comparison analysis for identification of the IO prominence condition

	Estimate	SE	*z*-value	*p*-value	
Adult vs. Age 3	4.9544	1.04924	4.722	<0.001	***
Adult vs. Age 4	5.431	1.05555	5.145	<0.001	***
Adult vs. Age 5	4.5948	1.04694	4.389	<0.001	***
Adult vs. Age 6	3.90548	1.0474	3.729	<0.01	**
Adult vs. Age 7	3.02951	1.05836	2.862	0.0843	.
Adult vs. Age 8	2.85826	1.06238	2.69	0.1322	
Adult vs. Age 9	2.76572	1.06488	2.597	0.1656	
Adult vs. Age 10	0.70856	1.25095	0.566	0.9997	

. = $0.05 < p < 0.1$, ** = $p < 0.01$, *** = $p < 0.001$

The results demonstrated that the identification rates performed by children aged three to seven were significantly different from adults' identification rates. However, children aged eight to ten showed no significantly different identification rates than adults. Our results suggest that when prominence was on an IO, Mandarin-speaking children younger than age eight have not fully developed an adult-like performance in resolving ambiguities related to *only* by means of prosody.

Next, we analyze the identification rates between different age groups when prominence was on a DO in a sentence. As shown in Figure 4b above, three- to five-year-olds also showed identification rates between 29.2% and 31.9%, which is very similar to and just below the random chance level (100/3 = 33.3%). Children aged six to eight displayed a similar trend; the identification rate fell between 45.8% and 54.2%. Nine-year-olds showed an increased identification rate, but the result was still far less accurate when compared to a group of adults (73.6%). Finally, ten-year-olds showed an identification rate of about 91.8%, whose performance was close to that of adults (94.4%).

Regarding the DO prominence condition, the result of the logistic regression analysis revealed that the main effect of age on identification

achieved a significant level (X^2 = 173.85, *df* = 8, $p < 0.001$). We subsequently conducted a multiple analysis comparison to examine which pair was significantly different between different age groups. For the same reason, we analyze only the outcomes that compare an adult group to each available age group. As in Table 5, unlike the IO prominence condition, all the age groups of children younger than age ten produced significantly lower identification rates than adults did; only ten-year-olds showed no significantly different identification rates from that of adults for the DO prominence condition. The results suggest that, based on our data, when prominence fell on a DO, children younger than age ten have not fully acquired a prosodic system for correctly disambiguating the sentence with the focus particle *zhi* 'only.'

Table 5. Multiple comparison analysis for the identification of the DO prominence condition

	Estimate	SE	*z*-value	*p*-value	
Adult vs. Age 3	3.643	0.579	6.294	$p < 0.001$	***
Adult vs. Age 4	3.776	0.582	6.491	$p < 0.001$	***
Adult vs. Age 5	3.776	0.582	6.491	$p < 0.001$	***
Adult vs. Age 6	3.041	0.572	5.320	$p < 0.001$	***
Adult vs. Age 7	2.757	0.571	4.825	$p < 0.001$	***
Adult vs. Age 8	2.700	0.572	4.724	$p < 0.001$	***
Adult vs. Age 9	1.825	0.585	3.118	$p = 0.045$	*
Adult vs. Age 10	0.438	0.675	0.648	$p = 0.999$	

* = $p < 0.05$, *** = $p < 0.001$

4. DISCUSSION

The goal of this study was to examine at what age children can perform in an adult-like manner in disambiguating a sentence with the focus particle *zhi* 'only' in Mandarin. We achieved this goal through a perception experiment with a picture-choice task, in which participants

listened to audio stimuli—stratified IO and DO prominence conditions—in a sentence and were instructed to identify a picture that represents one of the two prominence conditions. Results demonstrated that the identification rates performed by children varied by prominence conditions: the IO prominence condition was disambiguated earlier than the DO prominence condition. Furthermore, this type of ambiguity, associated with *zhi* 'only' in Mandarin, was shown to be a very late acquired phenomenon; before age ten, Mandarin-speaking children have not fully acquired a prosodic system for successfully disambiguating the sentence with the focus particle *zhi* 'only.'

One may wonder why the IO prominence condition was disambiguated before the DO prominence condition. There was a two-year gap between the IO and the DO prominence conditions among child participants in resolving a syntactic ambiguity associated with the focus particle *zhi* 'only.' We suggest two possible reasons. First, the IO prominence condition occurred in close proximity to the focus particle *zhi* 'only,' as in the sentence *Xiaoming zhi songgei Xiaohong yi ge bingqilin*. In this example, the IO *Xiaohong* occurs closer to the focus particle *zhi* 'only' than the DO *yi ge bingqilin*. This structural difference between the IO and the DO leads us to speculate that child participants found it easier to perform prosodic processing for the IO prominence condition. Second, as mentioned in footnote 1, although there were six types of DOs, only one type of IO (*Xiaohong*) appeared in our experiment. This unmatched number between the IO and the DO may introduce a bias toward responses for the IO prominence condition—which was linked to a higher identification rate, even among eight-year-olds—compared to the DO prominence condition.

The next question that we want to address is why Mandarin-speaking children showed a very late acquired phenomenon in fully resolving the syntactic ambiguity associated with the focus particle *zhi* 'only.' Several reasons may be interwoven with language development. First, Zhou et al. (2012) found that a syntactic ambiguity is disambiguated later than a speech act ambiguity (that is, a pragmatic one) by means of prosody. From birth, children naturally engage in repeated but varied question-and-answer dialogues with their parents and/or babysitters. Accordingly, the pragmatic use of prosody plays a more important role than the

syntactic use of prosody in developing basic communication skills (Zhou et al. 2012). The second reason may be that Mandarin is a tone language. Singh and Fu (2016) propose that acquiring a tone language is more challenging than acquiring a non-tone language. This is because the acquisition of a tone language requires an understanding of the interactions between lexical tone and intonation that are caused primarily by the manipulation of pitch level and range. In order to include non-tone languages as reference, we note that adult-like comprehension of the contrastive meaning *only* has been found as early as in five-year-olds in Turkish (Topaloğlu and Nakipoğlu 2015) and in English (Minai and Fiorentino 2010) and in six-year-olds in German (Müller et al. 2015), although a direct comparison cannot be made among different studies due to different task demands (Kim 2011). Taken together, it is understandable why only ten-year-olds performed in an adult-like manner in fully resolving the syntactic ambiguity of both the IO and DO prominence conditions tested in this study.

Although this study presented interesting findings about the syntactic ambiguity associated with the focus particle *zhi* 'only' in Mandarin, we identified several limitations in the method. First, although 108 listeners participated in this perception experiment, there were only 12 listeners in each age group. If we had recruited more listeners, our results would have been more representative of Mandarin-speaking children between the ages of three and ten. Our study was also limited by the small number of test sentences—there were only six test sentences used for each prominence condition. If more test stimuli had been used, this test would have led to a more valid generalization. Taking the first and second reasons together, the sample numbers of both speakers and test sentences should be sufficient to increase the statistical power of obtained data. Finally, this study included only one test item (Xiaohong) for the IO prominence condition. This design would have introduced clearly biased responses towards the IO prominence condition. Future research must consider a large and equal number of test items for both prominence conditions in order to enhance the generalizability of the study.

In summary, this study enabled us to estimate the age at which children can resolve the syntactic ambiguity associated with the focus

particle *zhi* 'only' in an adult-like manner by testing eight different age groups of Mandarin-speaking children. This study presented two main messages. First, the resolution of a syntactic ambiguity with *zhi* 'only' differed by prominence conditions (that is, IO and DO prominence conditions). This means that depending on the placement of prominence even within the same sentence, child participants showed different behaviors in resolving a syntactic ambiguity associated with *zhi* 'only.' In an attempt to obtain robust evidence, however, a thorough experimental design is needed to determine whether proximity or working memory is actually the main factor in this phenomenon. Furthermore, we found that children speaking a tone-language showed a very late acquired phenomenon in resolving a syntactic ambiguity with *zhi* 'only': only ten-year-olds were able to fully disambiguate target stimuli by means of prosody. This result provides seemingly convincing evidence that the development of the resolution of a syntactic ambiguity with *only* seems slower in a tone-language than in a non-tone language. For future research, in regard to this slower development, a direct comparison needs to be done between tone- and non-tone languages using a comparable experimental paradigm.

REFERENCES

Atkinson-King, Kay. 1973. *Children's Acquisition of Phonological Stress Contrasts*. Los Angeles: UCLA dissertation.

Carlson, Katy, Charles Jr. Clifton and Lyn Frazier. 2001. Prosodic boundaries in adjunct attachment. *Journal of Memory and Language* 45:58-81.

Chao, Yuen Ren. 1968. *A Grammar of Spoken Chinese*. Berkeley: University of California Press.

Choi, Youngon and Reiko Mazuka. 2003. Young children's use of prosody in sentence parsing. *Journal of Psycholinguistic Research* 32:197-217.

Cruttenden, Alan. 1974. An experiment involving comprehension of intonation in children from 7 to 10. *Journal of Child Language* 1:221-231.

Cutler, Anne and David A. Swinney. 1987. Prosody and the development of comprehension. *Journal of Child Language* 14:145-67.

Donselaar, Wilma van, Mariëtte Koster and Anne Cutler. 2005. Exploring the role of lexical stress in lexical recognition. *The Quarterly Journal of Experimental Psychology* 58:251-73.

Halbert, Anne, Stephen Crain, Donald Shankweiler and Elaine Woodams. 1995. Children's interpretive use of emphatic stress. Poster presented at the 8th Annual CUNY Conference on Human Sentence Processing, Tucson, USA.

Hirschberg, Julia and Cinzia Avesani. 2000. Prosodic disambiguation in English and Italian. In *Intonation*, ed. by Antonis Botinis, pp.87-95. Dordrecht: Kluwer Academic Publishers.

Hornby, Peter A. 1971. Surface structure and the topic-comment distinction: A developmental study. *Child Development* 42:1975-1988.

Hüttner, Tanja, Heiner Drenhaus, Ruben van de Vijver and Jürgen Weissenborn. 2004. The acquisition of the German focus particle *auch* 'too': Comprehension does not always precede production. In *Proceedings of the 28th Annual Boston University Conference on Language Development*, Boston, on-line supplement.

Kim, Soyoung. 2011. *Focus Particles at Syntactic, Semantic and Pragmatic Interfaces: The Acquisition of Only and Even in English*. Honolulu: University of Hawai'i dissertation.

Kuznetsova, Alexandra, Per Bruun Brockhoff and Haubo Bojesen Christensen. 2013. *lmerTest: Tests for Random and Fixed Effects for Linear Mixed Effect Models*. R package version 2.0-32. 23 June 2016. Web. 26 Nov. 2016. (http://cran.r-project.org/web/packages/lmerTest/index.html.)

Ladd, D. Robert. 1981. On intonational universals. In *The Cognitive Representation of Speech*, eds. Terry Myers, John Laver and John Anderson, pp.389-397. Amsterdam: North Holland.

Ladd, D. Robert. 1984. English compound stress. In *Intonation, Accent and Rhythm*, eds. Dafydd Gibbon and Helmut Richer, pp.253-66. Berlin: Walter de Gruyter.

Lee, Yong-cheol. 2012. Prosodic correlation between the focusing adverb *ozik* 'only' and focus/GIVENness in Korean. *Journal of Speech Sciences* 2:85-111.

Lee, Yong-cheol. 2015. *Prosodic Focus within and across Languages*. Philadelphia: University of Pennsylvania dissertation.

Lee, Yong-cheol, Ting Wang and Mark Liberman. 2016. Production and perception of tone 3 focus in Mandarin Chinese. *Frontiers in Psychology* 7.1058:1-13.

Liberman, Mark. 1975. *The Intonational System of English*. Cambridge: MIT dissertation.

Maratsos, Michael P. 1973. The effects of stress on the understanding of pronominal co-reference in children. *Journal of Psycholinguistic Research* 2:1-8.

Minai, Utako and Robert Fiorentino. 2010. The role of the focus operator *only* in children's computation of sentence meaning. *Language Acquisition* 17:183-190.

Müller, Anja, Barbara Höhle and Petra Schulz. 2015. The interaction of focus particles and information structure in acquisition. In *Language Acquisition and Development: Proceedings of GALA 2013*, eds. by Cornelia Hamann and Esther Ruigendijk, pp.330-42. Newcastle: Cambridge Scholars Publishing.

R Core Team. 2016. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing. Vienna, Austria. 31 Oct. 2016. Web. 26 Nov. 2016. (http://www.r-project.org.)

Shen, Xiaonan Susan. 1990. Tonal coarticulation in Mandarin. *Journal of Phonetics* 18:281-295.

Shih, Chilin. 1988. Tone and intonation in Mandarin. *Working Papers of the Cornell Phonetics Laboratory* 3:83-109.

Singh, Leher and Charlene S. L. Fu. 2016. A new view of language development: The acquisition of lexical tone. *Child Development* 87:834-854.

Solan, Lawrence. 1980. Contrastive stress and children's interpretation of pronouns. *Journal of Speech and Hearing Research* 23:688-698.

Topaloğlu, Simge and Mine Nakipoğlu. 2015. Preschoolers understand the focus particle 'Only' when given syntactic or pragmatic cues. Poster presented at the 40th Boston University Conference on Language Development (BUCLD 40), November 13-15, 2015, Boston University, Boston, USA.

Wang, Ting and Yong-cheol Lee. 2015. Does restriction of pitch variation affect the perception of vocal emotions in Mandarin Chinese? *The Journal of the Acoustical Society of America* 137:EL117-EL123.

Xu, Yi. 1994. Production and perception of coarticulated tones. *The Journal of the Acoustical Society of America* 95:2240-2253.

Xu, Yi. 1997. Contextual tonal variations in Mandarin. *Journal of Phonetics* 25:61-83.

Xu, Yi. 1999. Effects of tone and focus on the formation and alignment of f0 contours. *Journal of Phonetics* 27:55-105.

Xu, Yi. 2005. Speech melody as articulatorily implemented communicative functions. *Speech Communication* 46:220-51.

Xu, Yi and Ching X. Xu. 2005. Phonetic realization of focus in English declarative intonation. *Journal of Phonetics* 33:159-197.

Zhou, Peng, Stephen Crain, Liqun Gao and Likan Zhan. 2012. Children's use of phonological information in ambiguity resolution: A view from Mandarin Chinese. *Journal of Child Language* 39:687-730.

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APPENDIX

Sentences (1) through (6) indicate six test sentences and sentences (7) through (18) indicate filler sentences.

(1) 小明只送給小紅一個冰淇淋。
Xiaoming zhi songgei Xiaohong yi ge bingqilin.
Xiaoming only give Xiaohong one CL ice cream
'Xiaoming only gave Xiaohong an ice cream.'

(2) 小明只給小紅一個蘋果。
Xiaoming zhi gei Xiaohong yi ge pingguo.
Xiaoming only give Xiaohong one CL apple
'Xiaoming only gave Xiaohong an apple.'

(3) 小明只送給小紅一個杯子。
Xiaoming zhi songgei Xiaohong yi ge beizi.
Xiaoming only give Xiaohong one CL cup
'Xiaoming only gave Xiaohong a cup.'

(4) 小明只送給小紅一本故事書
Xiaoming zhi songgei Xiaohong yi ben gushishu.
Xiaoming only give Xiaohong one CL story book
'Xiaoming only gave Xiaohong a story book.'

(5) 小明只送給小紅一個皮球。
Xiaoming zhi songgei Xiaohong yi ge piqiu.
Xiaoming only give Xiaohong one CL ball
'Xiaoming only gave Xiaohong a ball.'

(6) 小明只送給小紅一塊蛋糕。
Xiaoming zhi songgei Xiaohong yi kuai dangao.
Xiaoming only give Xiaohong one CL cake
'Xiaoming only gave Xiaohong a piece of cake.'

(7) 小明在吃冰淇淋。
Xiaoming zai-chi bingqilin.
Xiaoming ASP-eat ice cream
'Xiaoming is eating an ice cream.'

(8) 小明拿著一把雨傘。
Xiaoming na-zhe yi ba yusan.
Xiaoming take-ASP one CL umbrella
'Xiaoming is taking an umbrella.'

(9) 小紅在放風箏。
Xiaohong zai-fang fengzheng.
Xiaohong ASP-fly kite
'Xiaohong is flying a kite.'

(10) 小明在滑滑梯。
Xiaoming zai-hua huati.
Xiaoming ASP-play slide
'Xiaoming is playing on a slide.'

(11) 小紅在看電視。
Xiaohong zai-kan dianshi.
Xiaohong ASP-watch TV
'Xiaohong is watching TV.'

(12) 小紅背著一個紅色的書包。
Xiaohong bei-zhe yi ge hongsede shuba.
Xiaohong carry-ASP one CL red bag
'Xiaohong is carrying a red bag on his back.'

(13) 小明在踢球。
Xiaoming zai-ti qiu.
Xiaoming ASP-kick ball
'Xiaoming is kicking a ball.'

(14) 小紅在畫畫。
Xiaohong zai-hua hua.
Xiaohong ASP-draw picture
'Xiaohong is drawing a picture.'

(15) 小明給了小紅一把傘。
Xiaoming gei-le Xiaohong yi ba san.
Xiaoming give-ASP Xiaohong one CL umbrella
'Xiaoming gave Xiaohong an umbrella.'

(16) 小明在和小狗玩。
Xiaoming zai he xiaogou wan.
Xiaoming ASP with puppy play
'Xiaoming is playing with a puppy.'

(17) 小紅在樹下。
Xiaohong zai shu xia.
Xiaohong in tree under
'Xiaohong is under a tree.'

(18) 小明給了小紅一個紅色的書包。
Xiaoming gei-le Xiaohong yi ge hongsede shubao.
Xiaoming give-ASP Xiaohong one CL red bag
'Xiaoming gave Xiaohong a red bag.'

兒童運用韻律解決由“只”引起的句法歧義：以普通話為例

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本研究旨在探尋以普通話為母語的兒童在何年齡階段成功地使用韻律解決由“只”引起的句法歧義。在本研究的實驗中，要求 3 到 10 歲的兒童被試者根據聽到的雙賓語句中的韻律來選擇與此句意義相匹配的圖片。實驗結果顯示被試者可以在更早的年齡階段識別韻律在間接賓語上的雙賓句意義，其原因一方面是間接賓語更靠近短劇詞“只”，另一方面歸因於有限的工作記憶。兒童較晚才能習得韻律來解決由“只”引起的句法歧義。實驗表明 10 歲年齡段的兒童能充分運用韻律解決由“只”引起的句法歧義，表現出和成人的無差異性。本研究的結果進一步印證了 Singh and Fu（2016）的觀點，由於聲調和語調的相互作用，聲調語言比非聲調語言習得得更晚。

關鍵字：韻律、句法歧義、兒童、普通話