



PROSODY AND WORD RECOGNITION IN BEIJING MANDARIN: A CASE STUDY

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ABSTRACT

Two experiments tested the role of an emerging syntactic tone in spoken word recognition of Beijing Mandarin Chinese, testing the role of the new syntactic tone in lexical access, and how synchronic change is perceived in the task of word recognition. Experiment One used an information-deprived condition where only information for the standard interpretation of the word was provided prior to the crucial tone. Experiment Two used a prosody-deprived condition where the prosodic cues were unclear. The results show that the tone had an impact on participants' lexical interpretations in both conditions, although the impact was more obvious in the first condition. The results support the hypothesis that the syntactic tone may be a precursor for word recognition.

1. INTRODUCTION

Mandarin Chinese is a tone language that utilizes tonal information for lexical distinctions. Accessing spoken words in the language depends heavily on lexical tones and their prosodic environment ([4], [7]). Unlike previous studies, which focus on lexical access from its tonal information, the current study investigates the effect of an emerging syntactic tone for accessing information of its following word, and the impact of current language change on spoken word accesses.

Mandarin Chinese has four basic tones associated with every lexical item. Using numbers 1-5 to indicate pitch height of the tones ([2]), 55 indicates a high-level tone: the pitch of a lexical item starts high and remains high. The tones 35, 51 and 214 are high-rising, high-falling and dipping tones respectively. In spoken discourse, lexical tones may change by following a set of tone sandhi rules ([2], [6]). Tone sandhi rules are a very important part of oral discourse: Native speakers repair their utterances when such a rule is violated. ([9]).

Contemporary Mandarin grammar specifies that a numeral must take a classifier before a noun ([6]). But in Beijing Mandarin this obligatory rule is changing, caused by sound erosion of a high-frequency unit formed with the numeral yi55 (one) and the general noun classifier ge51 ([8]). The numeral yi55 (one) follows a specific set of tone sandhi rules by taking a high-falling tone (yi51) before tones 55, 35 and 214, and a high-rising tone (yi35) before a high-falling tone 51. So yi55 assumes a high-rising tone when preceding the classifier (yi35 ge51). The combination occurs highly frequently as one phonological chunk in natural conversations, leading to phonological fusion and resulting in the complete loss of the general classifier. Controlled by the

missing classifier, the numeral yi35 keeps this tone and no longer follows the other tone sandhi rules, and yi35 alone can now precede nouns whose default classifiers may or may not be the general classifier ge51. Thus, the change has left a 'frozen' tone, and a noun phrase without the classifier. The 'frozen' tone assumes a syntactic function ([8]) as a syntactic tone: When the numeral yi55 (one) is paired with a lexical item that may function either as a classifier or a noun (e.g., che55: car), a lexical tone following the tone sandhi change brings out the standard interpretation of the word as a classifier (yi51 che55: a carload of). The syntactic tone indicates the word is a noun (yi35 che55: a car). Thus, the syntactic tone adds another candidate to the interpretation of the word following yi55. But the two candidates may not have equal chance of activation. Because the changing process is highly procedural ([1]) out of everyday use of the language, in experimental settings where participants may try to activate their declarative knowledge of the language for the tests, they may not be able to label the syntactic tone and the new pattern of noun phrases. This behavior has been observed very often as an asymmetry between language production and perception ([5]).

To examine the impact of the syntactic tone, two experiments were conducted to test two hypotheses. First, the syntactic tone hypothesis specifies that the tone is crucial for the interpretation of its following word. This hypothesis suggests that with the emergence of the syntactic tone, there are two candidates for the interpretation of the word following the numeral yi55, and the syntactic tone acts as a precursor for one of the interpretation. Second, the procedural knowledge hypothesis specifies that with reference to language change, there is an asymmetry between production and perception, which may affect lexical access following the syntactic tone in the experimental setting, resulting in a bias for the traditional grammatical interpretation of the word. However, if the effect of the syntactic tone can be observed despite of the bias, the results would provide stronger support for the first hypothesis.

2. EXPERIMENTS

Two experiments tested the two hypotheses, both using recorded passages ending with a combination of 'yi55 (one) + noun-like element.' The standard interpretation of the noun-like element is a classifier, which could be the preferred choice ([5]): If the prosodic information of the frozen/syntactic tone is neglected, then the combination can only take the standard interpretation 'numeral + classifier.' Thus the procedural knowledge hypothesis is expected in the tests. Yet if an alternative

interpretation is chosen following the syntactic tone, the result would support the syntactic tone hypothesis.

Each passage was recorded twice with the only difference being the two different tones on the numeral yi55. Depending on the crucial tone, the item following it could either be a noun or an elliptical nominal expression. Following each passage was a four-alternative multiple-choice question, focusing on the definition of the word after the crucial tone. The choices include a tone-based and grammar-based answer (based on the syntactic tone and the standard grammar respectively), an heuristic answer of either one or the other, and a denial. Nowhere were the prosodic or tonal cues mentioned so participants were left on their own to decide what information to pay attention to.

2.1. Experiment One

Experiment One tested both hypotheses by using an 'information deprived' condition: passages only made explicit information for the standard interpretation prior to the crucial tone, leaving the syntactic tone as the sole indicator of the syntactic tone-based answer. This condition violates the flow of information for reference presentation ([3]): It does not use a proper discourse pattern to introduce the information for the tone-based interpretation. Participants could be 'caught by surprise' with the tone-based lexical information.

2.1.1. Method

2.1.1.1. Participants

Fourteen native speakers of Beijing Mandarin participated. Among them were three men between the ages of mid-30 to mid-40, and 11 female participants, including three children (one 11 year-old and two young teenagers) and eight adults in the age range of mid-30 to early 70. All participants took the test voluntarily.

2.1.1.2. Materials

Two passages were used, each containing a short narrative ending with a word combination yi55 (one) plus a noun. One passage involves a boat (thus the Boat Passage) and the other involves a box, thus the Box Passage. Each passage was recorded twice onto separate audiotapes in identical forms except for the tonal variations on the word yi55. The crucial tone is yi35, a high-rising tone, in comparison to yi51, a high-falling tone that follows the Mandarin tone sandhi rules. Taking the Box Passage as an example, 'yi35 he35' means 'one box', and 'yi51 he35' means 'a boxful of bridges (string supports for musical instruments).' The former interpretation is brought about by the syntactic tone, and the latter follows the general Mandarin grammatical pattern. In the Box Passage, only bridges were mentioned and the word 'box' appeared only once as the last word of the passage. The grammar-based answer would be 'a box of bridges,' which was a natural extension of the passage about musical bridges. The tone-based answer would be 'one instrument case,' a new piece of information. Following the passage was a

four-alternative multiple-choice question, asking whether the passage talked about '1. an instrument case; 2. a box of bridges; 3. a case or a box of bridges; and 4. none of the above.' In the multiple-choice questions, the standard classifiers were added between the numeral and the noun. The noun 'instrument case' takes the general classifier 'ge51,' yet the standard classifier for 'boat' is 'tiao35,' which was used in the question.

Passages were recorded in a female voice, and the speed was slower than that in natural conversations.

2.1.1.3. Procedure

Participants took the test individually in a relatively quiet room. A verbal instruction was recorded before each set of passages. The instruction asked participants to listen to each passage, then choose the answer that they felt the most appropriate to the passage. Material presentation was counter balanced so that participants in Group 1 heard the Box Passage ending with the syntactic tone (yi35), and the Boat Passage with the grammar/sandhi tone (yi51), and vice versa for Group 2. All answers were videotaped. Process time was not monitored so participants were under no time pressure for choosing their answers.

2.1.1.4. Design

The main dependent variable examined was word recognition following the syntactic tone. There were three independent variables, one between-subjects variable—the passage experience of the test group (Box, Boat), and two within-subjects variables—passage conditions (yi35, yi51) and choice of answers for each passage (tone based, grammar-based).

2.1.2. Results and Discussion

The results are summarized in Table 1 in terms of the mean proportion of answer choice as a function of test group, passage condition, and choice of answer for each passage. Due to educational background and cultural differences, not all participants were able to deal with the multiple-choice questions; thus some participants chose an answer unrelated to the passage. Some hesitated for quite some time before making a guess for an answer. The analysis was only based on the tone- and grammar-based answers.

Table 1

Mean Proportion of Answers as a Function of Test Group, Passage Condition, and Tone/Grammar-based Answer choice in Experiment 1

Test Group	Passage Condition and Answer Choice			
	Yi35		Yi51	
	T	G	T	G
1 (Box, Boat)	.429	.286	.143	.714
2 (Boat, Box)	.714	.286	.143	.571

Note: T: Tone-based answers;

G: Grammar-based answers

As expected on the basis of the syntactic tone hypothesis, the participants were able to access both interpretations following either the syntactic tone or the grammar/sandhi tone. Therefore, the overall performance of the two test groups was similar for both passages. Specifically, the answers from both groups conform to the syntactic tone and to the grammar/sandhi tone change. In other words, the tone-based answers were chosen more for the passages that contained the syntactic tones, and vice versa. Due to different passage conditions, the choice of answers for the same passage was different between test groups.

These observations are supported by a multifactorial mixed, unweighted analysis of variance, which yielded a significant two-way interaction of passage condition by answer choice, $F(1, 12) = 5.7$, $MSE = .3810$, $p < .05$. Passage condition by test group showed a small marginal interaction, $F(1, 12) = 3.4$, $MSE = .0476$, $p < .1$. Test group did not show any significant main effect, $F(1, 12) < 1$, nor was there any significant interaction of test group, passage condition by answer choice, $F(1, 12) < 1$, suggesting no significant effect of passage condition and answer choice across participants.

The results of Experiment One support the syntactic tone hypothesis. Specifically, all things being equal, participants from both groups gave two different interpretations of the same lexical item based on the tonal information of the numeral immediately preceding the item. The information-deprived condition did not interfere with participants' lexical judgment for the tone-based interpretation: participants in both groups favored the tone-based answers when the syntactic tone (yi35) was present. Hence the syntactic tone was crucial for the access of lexical information. The results suggest that there are two prelexical interpretations of the word following the numeral yi55, and the syntactic tone is crucial for bringing out one interpretation.

A few participants chose the alternative heuristic answers. The reason could be they either could not handle the unexpected new information after the syntactic tone, or that they neglected the prosodic cues and exercised their declarative knowledge; thus unsure between the tone- or grammar-based interpretation, a support to the procedural knowledge hypothesis.

2.2. Experiment Two

Experiment Two tested both hypotheses by using a 'prosody-deprived' condition: Tests were conducted in a normal high-school classroom. The classrooms were full of noise from both inside (four electric fans rowing with personal hand-held fans in a temperature of around 39 degrees Celsius) and from outside (construction on campus). The windows were all open due to the heat.

Participants were tested together in two large groups. Test passages properly introduced information for both tone-based and grammar-based answers prior to the crucial tone. Participants in Experiment Two had more uniform background than did those in Experiment One.

2.2.1. Method

2.2.1.1. Participants

Eighty native speakers of Beijing Mandarin participated in Experiment Two. They were all eleventh grade high school students from a top high school in Beijing, China. The participants came from two classes, one preparing for the college entrance examination for humanities majors, and the other for science majors. They took the test by following the instruction of their teachers. All participants were aged 16-17 with similar educational background. They were all familiar with the test format.

2.2.1.2. Materials

Two passages were used. One involved a car, thus the Car Passage. The tone-based answer was 'one car,' and the grammar-based answer was 'a carload (of watermelon).' The passage properly introduced both the car and watermelon before the crucial tone appeared. The other passage was a revised version of the Box Passage from Experiment One. The passage properly introduced both the instrument case and the bridges before the crucial tone. A four-alternative multiple-choice question was recorded following each passage. All the answer choices were printed on a piece of paper.

The two passages were recorded onto two audiotapes in alternating tonal conditions, one in a male and one in a female voice. Following each passage the multiple-choice question was also recorded. The classifiers were mentioned for the tone-based answers. The noun 'car' was paired with its regular classifier 'liang51' (yi35 liang51 che55: one car/vehicle). Again, the speed of the recording was slower than that in natural conversations.

2.2.1.3. Procedure

Participants took the test in two sessions in their regular classrooms. Right before the test, the examiner first distributed the answer sheets to all participants, then gave a verbal instruction asking participants to listen to each passage and the question, then to circle one answer that they felt the most appropriate to the passage they had just heard. Participants were instructed to raise their heads after they had chosen the answer. The second passage was presented after all participants finished the first passage. Passage presentation kept the same order. Group 1 processed the Car Passage in the syntactic tone condition, and the Box Passage in the grammar/sandhi tone condition. Group 2 processed the Car Passage in the grammar/sandhi tone condition, and the Box Passage in the syntactic tone condition. Again, process time was not monitored so participants were under no time pressure in choosing their answers.

2.2.1.4. Design

Again the main dependent variable examined was word recognition following the syntactic tone. There were three independent variables, one between-subjects variable--the passage experience of the test group (Car, Box), two within-subjects variables--passage condition (yi35, yi51) and tone- and grammar-based answers.

2.2.2. Results and Discussion

The results are summarized in Table 2 in terms of the mean proportion of the answers as a function of test group, passage condition, and choice of answers.

Table 2
Mean Proportion of Answers as a Function of Test Group, Passage Condition and Four Answers in Experiment 2

Test Group	Passage Condition and Answer Choice Yi35				Yi51			
	T	G	E/O	N	T	G	E/O	N
1 (Car, Box)	.300	.525	.125	.050	.125	.550	.225	.100
2 (Box, Car)	.250	.550	.100	.100	.125	.800	.000	.075

Note: T: Tone based answers;

G: Grammar-based answers;

E/O: either tone- or grammar-based answers;

N: none of the above answers

Although passages contained information for both interpretations, in the prosody-deprived condition, the participants from both test groups appeared to favor the grammar-based answers in both passage conditions. Yet the results still indicate that passages ending with the syntactic tone differ from those ending with the grammar/sandhi tone, and the two passages were treated differently by the two test groups, indicating that the syntactic tone still had an impact on the task of word recognition.

These observations are supported by a multifactorial mixed, unweighted analysis of variance, which yielded a significant main effect of answer choice, $F(1, 78) = 33.7$, $MSE = .3913$, $p < .001$, as well as a significant two-way interaction of test group by passage condition, $F(1, 78) = 5.0$, $MSE = .0752$, $p < .05$. Most importantly, there was also a two-way interaction of passage condition by answer choice, $F(1, 78) = 7.0$, $MSE = .2365$, $p < .01$, suggesting that the two passages were processed differently by the two test groups of participants, and the answer choices varied following tone variations across participants. Again, test group did not show a significant main effect, $F(1, 78) = 3.3$, $MSE = .0768$, $p < .1$, nor was there a significant main effect of passage condition, $F(1, 78) < .1$, suggesting no consistent effect of passage condition within a test group.

A separate analysis on the heuristic and the 'none' answers also yielded a significant two-way interaction of test group by passage condition, $F(1, 78) = 5.0$, $MSE = .0752$, $p < .05$, suggesting the passages were treated differently by the two groups of participants.

Although the test was under the 'prosody-deprived' condition, the results still yielded support for the syntactic tone hypotheses by showing an impact of the syntactic tone on word recognition. The results support the procedural knowledge hypothesis by showing that when prosodic cues were unclear, participants chose their answers according to the standard grammatical pattern, suggesting that the grammar-based answer has stronger weight to be the preferable choice of the two lexical candidates.

3. DISCUSSION

The results from both experiments demonstrate that the syntactic tone not only brought a new grammatical pattern into the language, it also affects spoken word access. Specifically, under both the information- and prosody-deprived conditions, even when the procedural knowledge hypothesis was evident (Experiment two), participants chose the tone-based answers more readily with the presence of the syntactic tone even when they were not prepared for the information brought about by the syntactic tone (Experiment One).

It is unclear at this stage whether the syntactic tone will become part of standard Mandarin grammar. At present, the results of this study suggest that when there are two potential lexical interpretations, the syntactic tone may act as a precursor for spoken word recognition.

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