An Acoustic Study on The Effects Intonation Imposes on Sentence-final Particles in Nanjing Dialect

Yuge Liu*

Zhejiang University, Hangzhou, China

Abstract. To investigate the interaction between tone and intonation on the production of the sentence-final syllables and the effects of a specific type of characters, i.e. sentence-final particles (SFPs) in Nanjing dialect, acoustic analyses were carried out in the current study. Participants were asked to produce sentences under four conditions: (1) SFPs in interrogative sentences; (2) SFPs in declarative sentences; (3) homophones of the SFPs in interrogative sentences; (4) homophones of the SFPs in declarative sentences. The acoustic productions were analyzed in order to compare the same SFPs in different intonation patterns, i.e., interrogatives and declaratives, and SFPs and their homophones in the carrier sentences. Results showed that the influence of intonation on tones within sentence-final syllables indeed exists, but SFPs mitigate the extent to which intonation functions. These results suggest that intonation is present in tonal languages as well, whereas SFPs influence the realization of intonation by reducing the extent of global rising.

Keywords: Tone, Intonation, Sentence-Final Particles, SFPs, Nanjing Dialect, Acoustic Study.

1. Introduction

Tone and intonation are two commonly researched features in prosody studies that are closely related to each other. Intonation refers to the overall changes in the pitch at the sentence level (Cao, 2002), while tone refers to the functioning of the fundamental frequency at word or syllable level (Connell, et al., 1983). Both of them carry the function of differentiating meanings. To be more specific, intonation distinguishes among sentence types, while tone conveys differences in word meanings (Li, et al, 2021), though tones are not semantically distinctive in every language. In the so-called non-tonal languages, intonation alone is applied to express distinct meanings. In tonal languages, on the other hand, whether intonation exists and how it influences tones are still under debate.

The first and probably most famous theory on the interaction between tones and intonation focusing on Chinese was proposed by Chao (1922). He argued that tones and intonations are likened to small waves and big waves with the relationship of "algebraic sums" between the two. Chao's other studies (e.g. 1932;1933) further discussed the function intonation takes in a tonal language. Chang's research (1958) supported that intonation is superimposed on tones but the effect of the two is not simply an addition. It pointed out that rising tones are leveled under the influence of a falling intonation, and falling tones are leveled by a rising intonation. These results, together with some more recent studies (Connell, et al, 1983; Vance & Timothy, 1976), emphasize the influences of intonation on tone production.

Nevertheless, some other phoneticians believed that the lexical tone system hampers the extent to which intonation can be applied in a tonal language (e.g. Ma, et al, 2006; Wu, 2008; M García-Gutiérrez, et al., 2010). Thus, many have tried to explain why intonation is restricted with tones present. As it is widely accepted that intonation expresses emotions and mood in non-tonal languages (Luke, 1990; Matthews & Yip, 1994; Wu, 2008), Feng (2015) found out that these roles are often undertaken in tonal languages such as Chinese by a specific type of words, i.e., the sentence-final particles (SFPs). However, few of them have carried out experiments to support their theories. The present research intends to fill this gap by conducting acoustic analyses with the interaction between intonation and SFPs as the object of observation.

In recent years, acoustic analysis lends power to examine the effect of the interaction between tone and intonation on the realization of SFPs. For instance, Tsui and Tong's study (2018) recorded and analyzed the utterances of native Cantonese speakers with declarative and interrogative SFPs to explore the effect of the intonation on the tones of the SFPs bearing the same underlying lexical tone. The results demonstrated that SFPs and final pitch rising, a cue for interrogative intonation, are in complementary distribution, thus supporting that intonation is greatly restricted in tonal languages. Meanwhile, linguists who consider intonation functions in tonal languages made use of acoustic analysis. For example, Boulakia and his fellows (2004) studied Mandarin where they found that interrogative sentences

* Corresponding author: liuyuge515@126.com

tended to have a rising intonation even with the SFP in the sentence, offering evidence that intonation is present in tonal languages and plays an important role on the syntactic-pragmatic level.

However, the study on the tone-intonation interaction in Chinese is still limited to only some dialects. Nanjing dialect, which belongs to Jianghuai Mandarin, might also provide unique tonal and intonational patterns and SFPs to be explored. Although many descriptive studies on the general system of the Nanjing dialect have been attempted, only Zhu's dissertation (2011) offered a comprehensive description of the particles in Nanjing dialect. However, it concentrated on the descriptive and functional part of particles and no phonological information of the SFPs was offered. Hence, there has been no existing research exploring the interaction between intonations and tones on SFPs in the Nanjing dialect. This insufficiency is another reason to conduct the present study which adopts acoustic analyses to explore the effects intonation imposes on the tonal production of SFPs in Nanjing dialect.

This study sets out to answer the following questions.

Research question 1: Does intonation have influences on the tones of SFPs in Nanjing dialect? If it is true, to what extent?

Hypothesis 1: Intonation influences the tones of SFPs in Nanjing dialect and both functions to express interrogative mood.

Research question 2: Is the influence a result of the innate features of SFPs as a special word type?

Hypothesis 2: The influence still displays when SFPs are replaced by ordinary words.

2. Methods

2.1 Stimuli and design

In the current study, two SFPs were selected to construct experimental materials, as both of them can be used in both declarative and interrogative sentences (cf. table 1). Near homophones of the SFPs were chosen to form the other half of the experimental sentences. The syllables with asterisks were different in their citation tones, but they were all produced with tone 0 in the designed sentences.

Table 1. The two target SFPs and their (near) homophones

SFPs	homophones
啵 /bo4/	包 /bo4/
	波 /bo4/
*啖 /læ1/	*奶 /læ3/
	*来 /læ2/

A total of 16 different utterances were produced with the two SFPs and their homophones (2 target SFPs × 4 homophones × 2 types of sentences). These utterances were divided into 4 conditions: (1) SFPs at the end of interrogative sentences; (2) SFPs at the end of declarative sentences; (3) homophones of the SFPs at the end of interrogative sentences; (4) homophones of the SFPs at the end of declarative sentences.

8 sentences were designed: (1) /ni1 ki1 mæ1 mjæn1 bo4/ (SFP: "You'll go to buy some bread."; homophone: "You'll go to buy some noodle."); (2) /ʈʂɛ1 weɪ1 ʂɻ1 wɑŋ2 tɕʰjɑŋ2 bo4/ (SFP: "This is Wang Qiang Bo."; homophone: "This is Wang Qiang"); (3) /ni1 ɕjæn1 tsaɪ1 tɛɪou1 hueɪ3 læ/ (SFP: "You'll go back now."; homophone: "You'll go back now."); (4) /wo1 ki1 ʈʂɑʊ3 lɪou2 laɪ3 læ/ (SFP: "I'll go to find some milk."; homophone: "I'll go to find Grandma Liu."). Each sentence could have either an interrogative or a declarative intonation, depending on the punctuation attached to it. The same syntactic structure is maintained to realize same prosodic structure across conditions.

2.2 Participants

Eight native speakers of Nanjing dialect (four females and four males) were recruited. They were all above 50 years old and lived in the south part of Nanjing where the most authentic Nanjing dialect was originated. All of them had signed the informed consent forms sent in electronic edition through Wechat before the experiment and received rewards for their participation.

2.3 Procedure

The experiments were conducted online through Tencent Meeting due to the pandemic. The sixteen sentences were shown in random order in PowerPoint. The speakers were then asked to pronounce the sentences one by one. Each sentence was produced three times to avoid random effects at individual production. All recordings were recorded via Praat (Boersma and Weenink, 2017) at a sampling rate of 44.1 kHz on a MacBook Pro PC.

2.4 Data analysis

The acoustic analysis was performed with Praat (Boersma and Weenink, 2017). The tone domain of the penultimates and the last syllables of each utterance were segmented manually according to the spectrogram, waveform, and auditory input. A Praat script Prosody Pro (Xu, 2013) was used to extract the time-normalized f0 at ten evenly-spaced time points.

In order to eliminate the influence of differences among speakers, the productions by different speakers were averaged in each condition. The pitch contours of the penultimates and the last syllables were first drawn to show the qualitative differences across conditions. Averages of the pitch values of these ten-time points were then calculated and submitted to linear mixed-effect models in R.

3. Results

3.1 Pitch contour

The pitch contours of the last syllables pronounced "bo" across the four conditions are shown as Figure 2. Each of these syllables revealed a falling pitch, among which those with SFPs displayed greater extent of declining and

shared similar f0 values and tendency. In addition, interrogative sentences without SFPs bore the highest f0 values.

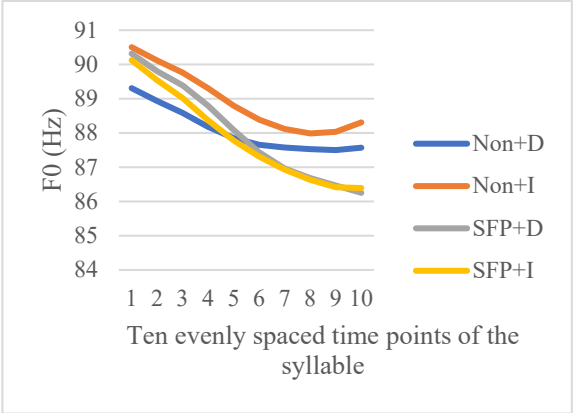

Fig. 1. The pitch contours of the last syllables pronounced lai in four conditions.

Figure 1 presents the pitch contours of the last syllables pronounced "lai" across the four conditions. It can be observed that all the syllables displayed a rising pitch except for the SFPs in declarative sentences whose tendency is level and even falling. Moreover, sentences without SFPs, whether they are declaratives or interrogatives, had overall higher f0 values than those with SFPs.

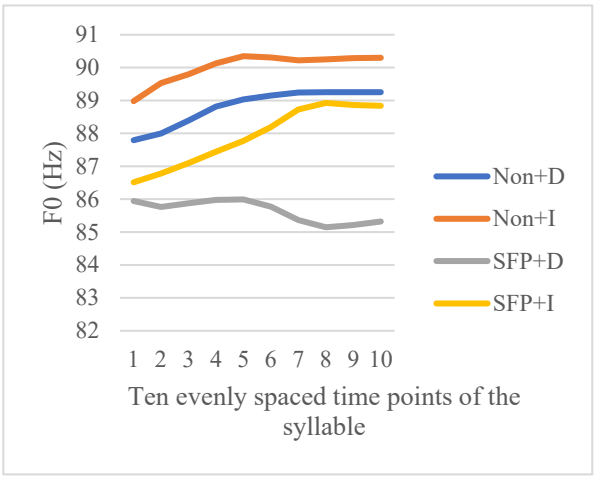

Fig. 2. The pitch contours of the last syllables pronounced bo in four conditions.

Statistical analyses basically agreed with the observations. The results of t-tests between pairs of the lai syllables further confirmed that the last syllables in the four conditions have different pitch contours. Significant differences were found between all the pairs, as Table 2 shows. However, the pair "Non+D and SFP+D" of the bo syllable shows no significant difference and a marginal difference was found between the pair "SFP+D and SFP+I".

Table 2. The results of t-tests between the last syllable of different conditions

syllables	"bo"		"lai"	
t/p value	t-value	p-value	t-value	p-value
Non+D and Non+I	-9.156	<.005	-19.999	<.005
Non+D and SFP+D	0.177	0.864	12.390	<.005
Non+I and SFP+I	7.320	<.005	10.933	<.005
SFP+D and SFP+I	3.026	0.014	-5.909	<.005

3.2 Pitch height

The pitch heights of the penultimate syllables and the last syllables across the four conditions were measured to determine the effect of intonation and particle. The pitch heights of the two syllables were calculated by averaging the 10 evenly spaced f0 estimates and then submitted to a linear mixed effects model. In these two models testing penultimates and last syllables respectively, *pitch heights* both served as the dependent variables while *intonation* (declarative vs. interrogative) and *particle* (particle vs. non-particle) were entered as fixed effects. To exclude the impact of other variables, the intercept for *ages* and *genders* were entered in the random-effects structure.

For the last syllables, a marginally significant ($\beta(124) = -3.180$, $p < 0.05$) was found, where the non-particles bore a higher pitch height than particles. The effect of intonation was, however, not significant, ($\beta(124) = 1.198$, $p = 0.4237$). Neither was the interaction effects between *intonation* and *particle* significant, $p = 0.6151$. For the penultimates, no effect nor interaction was found. (*intonation*:$\beta(124) = 0.86524$, $p = 0.514$; *particle*:$\beta(124) = -0.04848$, $p = 0.971$; *interaction*:$\beta(124) = -1.03861$, $p = 0.580$)

3.3 Pitch slope

To explore the trend and the degree of the changes in pitch heights, the subtractions between the pitch heights of penultimates and last syllables were also calculated and then submitted to a linear mixed effects model where *differences* were entered as the dependent variables while *intonation* and *particle* were entered as independent variables. The intercept for *ages* and *genders* were entered in the random-effects structure.

A significant effect of *particle* was found ($\beta(125) = -2.0803$, $p < 0.01$); non-particles led to larger increases after the penultimates, indicating that particles leveled off the rising pitch heights. The effect of *intonation* was found marginally significant ($\beta(125) = 1.3837$, $p = 0.05328$); interrogative intonation increased the degree of tone elevation at the last syllable. No interaction effects between *intonation* and *particle* were found.

4. Discussion

The current research investigated the impact intonation poses on the SFPs in Nanjing dialect.The influences on the SFPs and their homophones were compared to investigate the function of the SFPs to convey the intonation. The impact of intonation is consistent for words with different tones.

The results showed that the different intonation patterns, i.e., interrogative vs. declarative, influence the pitch slope between the penultimate and the last syllables with increases in the degree of tonal elevation in interrogative sentences. On the other hand, particles themselves exert impact both on the pitch height of the last syllable and the pitch slope from the penultimate to the last syllable. These results are discussed as follows.

4.1 The influence of intonation

The impacts of intonation were firstly observed in the pitch height of the last syllables. Compared with the last syllables in declarative sentences, those in interrogative sentences displayed higher pitches. Meanwhile, the last syllables in interrogatives sentences without particles bore the highest f0 value. This could be due to the rising intonation at the end of a sentence to express interrogative mood. This pattern is in line with previous studies on non-tonal languages, such as English, where the phenomenon is generalized as Strong Universalist Hypothesis (Ladd, 1981). However, in tonal languages such as Chinese, whether intonation has a similar influence on tonal production has been controversial. Supporters investigated different intonation in exclamatory, interrogative, and declarative sentences as well as different tonal languages and dialects (Chang and Nien-Chuang, 1958; Ho and T. Aichen, 1977). Meanwhile, opponents attributed the variation to other reasons, such as innate physiological conditions (Vance, T. J., 1976; Pollack & Lieberman, 1968). The current finding offers further evidence that the tones of individual characters in Chinese are also affected by the intonation, as in English and other non-tonal languages.

However, the contour of the last syllables in declarative sentences without particles was different from what was expected. A level contour was expected given the findings that the declarative mood does not typically lead to a rising intonation (Yuan, 2002). Nevertheless, it still bore a rising tendency which is probably driven by a joint result of the interrogative-inclining declaratives and the innate rise at the end of a sentence in Nanjing dialect. First, in experimental sentences like *I'll go to get some milk*, it could incline a question that if there is a need for "me" to get some milk. Also, in sentences like *You'll go to buy some bread* which have an imperative interpretation, speakers would probably also choose to use an inquiring intonation to make the imperative mood sound less offensive. Meanwhile, sentences in Nanjing dialect always bear a rising intonation which is not uncommon in Chinese dialects. Previous studies found that many other dialects displayed a rising intonation at the end of a sentence, such as Jinzhou dialect (Qi, 2007) and Tangshan dialect (Ji & Yan, 2018). According to the native speakers and the personal experience of the author who was born and lives in Nanjing, the duration of the last few syllables in Nanjing dialect is either excessively long or quite short, where the short ones are frequently accompanied by an obvious rise in pitch. The SFPs and their homophones chosen in the present experiment, incidentally, were short ones. Therefore, with the special feature in Nanjing dialect and the imperative implication working together, rises on the last syllables in declaratives without particles were formed. More studies in the future are needed to explore this tendency, especially focusing on imperative mood to offer more solid evidence.

This special feature of rising intonation in Nanjing dialect may also explain why the statistical analysis did not reveal significant effects of intonation on pitch heights of the last syllables, which deviates from the hypothesis. The chosen materials may also be responsible for the discrepancy. In order to avoid the influence of the tone of the syllable itself on the results, the experimental materials were supposed to be selected as homophones yet only near homophones were found. The deficient number of SFPs in Nanjing dialect was also an obstacle to find homophones. Therefore, some of the stimuli may bear a rising pitch themselves when placed at the end of the sentence, regardless of the intonation of the sentence.

To further scrutinize the effect of the interrogative intonation on the pitch rising which could have been masked by the inherent higher pitch produced at the end of a sentence in Nanjing dialect, the results of the pitch slope analysis may be more of interest. Statistical results on the subtraction of the last and the penultimate syllables revealed a marginal effect of intonation. It suggests that intonation has a positive relationship with the rising tendency, meaning that interrogative intonation intensified the upward tendency. The successful discovery of the effect of intonation again supported the previous theory that intonation functions in tonal languages as well (Chao, 1932; Chao, 1933).

4.2 The influence of particle

The second aim of the study was to investigate the influence of SFPs on tonal production, which was indeed significant. Higher *f0* values of the last syllables were observed in non-particle conditions. It demonstrated that SFPs are another way to construct a question sentence in Chinese besides changes in intonation. Some Chinese linguists put forward the theory that the function which intonation undertakes in English is taken over by SFPs in Chinese (Chao, 1932) and SFPs are a variation of intonation (Feng, 2015). To be more precise, SFPs weaken functions of intonation, which was presented as lowering the pitch height of the last syllables. The current result is in accordance with previous researches which suggested that the occurrence of SFPs somehow undertakes the function of intonation (Rumjancev and K., 1972). However, SFPs didn't completely exclude the impact of intonation. Previous studies claimed that the tone of SFP and a global rise in the intonation have positive interaction on each other (Fang, 2003; Fox, Luke & Nancarrow, 2008; Boulakia, et al., 2004), i.e., even though SFPs express the major interrogative mood, the

sentence would still show a rising tendency. It was demonstrated in the present study, where the last syllables in interrogative sentences with SFPs still displayed a rising contour.

Statistical analyses of the pitch height found a marginally significant effect of *particle.* The lower pitch height of particles than non-particles again supported the hypothesis that sentence-final particles alleviate the global rising of interrogatives. It is a phenomenon that has been observed in many tonal languages, such as Cantonese and Mandarin (Ma, et al.,2006; Connell, 1983). The current study offers further evidence on Nanjing dialect: SFPs influence the realization of intonation by reducing the extent of global rising.

In the pitch slope analyses, particles showed significant effects as well. The result suggested that particles negatively correlate with the rising tendency. Compared with sentences without particles, those with particles had a less increased pitch value from the penultimate to the last syllable, suggesting that SFPs flattened the general intonation. The specific characteristics of sentence-final particles were once more illustrated. Nevertheless, some discrepancies still lied in the result. The analysis of the pitch heights of the penultimate syllables, which was collected aforehand to calculate the degree of increase in pitch height, resembles its counterparts in Cantonese which found that the SFPs did not lead to differences in the penultimates' F0 (Wu, 2013). However, the authors also pointed out that questioning SFPs also led to remarkable changes in the penultimate syllables, which is not found in the present study. The discrepancy is probably also caused by the feature of global rising in all sentences in Nanjing dialect, thus reducing the impact of questioning SFPs.

4.3 Limitations

Admittedly, there were some flaws in the experiment that could have led to the unexpected results. Except for the imperative intonation hidden in the designed sentences and the limited choice of SFPs, it was difficult to transcribe oral syllables in dialects into written characters which can be easily recognized by dialect speakers. When the subjects read the given sentences, many of them were confused at first until the experimenter's illustration, and thus the recordings were not as natural as they were actually talking in reality. What is more, due to an accident outbreak of coronavirus in Nanjing during data collection, the government required all Nanjing citizens to stay at home. Consequently, the experiment was conducted online through video conference. It was harder to make sure that the subjects fully understood the experimental instructions and the quality of the recording was not as good as those recorded in the laboratory. Further studies may obtain recordings of better quality after the recovery from the pandemic.

References

1. Boulakia, G., Martin, P., Zeng, X.: Tones and Intonation in Declarative and Interrogative Sentences in Mandarin. In: The International Symposium on Tonal Aspect of Languages: Emphasis on Tone Languages. Phonology Laboratory, Institute of Linguistics, Chinese Academy of Social Sciences, Beijing (2004)
2. Cao, Jianfen.: The relationship between tone and intonation in mandarin chinese. Zhongguo yuwen (2002).
3. Chang, & Nien-Chuang.: Tones and intonation in the chengtu dialect (szechuan, china). Phonetica, 2(1-2), 59-85 (1958).
4. Chao, Y.-R.: A preliminary Study of English Intonation and its Chinese Equivalents. Cai Yuanpei xiansheng liushiwusui qingzhu lunwenxuan, 104–156 (1932).
5. Chao, Y.-R.: Tone and intonation in Chinese. Zhongyanyuan shiyusuo jikan, 4(3) (1933).
6. Connell, B. A., Hogan, J. T., Rozsypal, A. J.: Experimental evidence of interaction between tone and intonation in mandarin chinese - sciencedirect. Journal of Phonetics, 11(4), 337-351 (1983).
7. Fang, X. Y.: Guangzhou fangyan jumo yuqi zhuci [Sentence-final mood-helping words in Guangzhou dialect]. Jinan University Press, Guangzhou (2003).
8. Fox, A., Luke, K.-K., Nancarrow, O.: Aspects of intonation in Cantonese. Journal of Chinese Linguistics, 36(2), 333–367 (2008).
9. Ho, Aichen, T.: Intonation variation in a mandarin sentence for three expressions: interrogative, exclamatory and declarative. Phonetica, 34(6), 446-457 (2009).
10. Ladd, D Robert. On intonational universals. Advances in Psychology, 389-397 (1981).
11. Li, Y., Tang, C., Lu, J., Wu, J., Chang, E. F.: Human cortical encoding of pitch in tonal and non-tonal languages. Nature Communications, 12(1) (2021).
12. Luke, K-K.: Utterance Particles in Cantonese Conversation. Amsterdam: Benjamins (1990).
13. M García-Gutiérrez, Missana, T., Molinero, J., Yllera, A., Mingarro, M.: Modelling the interaction of intonation and lexical tone in vietnamese. Speech Prosody, 31(3), 74-78 (2010).
14. Ma, K. Y., Ciocca, V., Whitehill, T. L.: Effect of intonation on cantonese lexical tones. Journal of the Acoustical Society of America, 120(6), 3978-3987 (2006).
15. Matthews, S., Yip, V.: Cantonese: A Comprehensive Grammar. Routledge, London and New York (1994).
16. P.Boersma, D.Weenink, Praat:Doingphoneticsbycomputer (version 6.0.24). Amsterdam: University of Amsterdam, 2017.
17. Pollack, I., Lieberman, P.: Intonation, perception and language. The American Journal of Psychology, 81(4), 615 (1968).
18. Rumjancev, M. K.: Toni Intonacija v Sovremennon Kitajskom Jazyke (Tone and Intonation in Modern Chinese). Journal of Chinese Linguistics, 6:120-168 (1972)

19. Tsui, R., Tong, S. X.: An Acoustic Study on the Effect of the Interaction between Intonation and Lexical Tones on the Realization of Cantonese Sentence-final Particles. In: Proceedings of the 9th International Conference on Speech Prosody 2018. Poznań (2018).
20. Vance, J. Timothy: An Experimental Investigation of Tone and Intonation in Cantonese. Phonetica, 33.5:368-392 (1976)
21. Wu, W. L.: An Acoustic Phonetic Study of the Intonation of Sentence-Final Particles in Hong Kong Cantonese. Asian Social Science 4(2) (2008)
22. Wu, W. L.: Cantonese Prosody: Sentence-final Particles and Prosodic Focus. Doctoral thesis, University College London (2013)
23. Xu, Y.: ProsodyPro—A tool for large-scale systematic prosody analysis. Laboratoire Parole et Langage, France (2013).
24. Yuan, Jiahong, C. Shih, G. P. Kochanski: Comparison of Declarative and Interrogative Intonation in Chinese. Industrial Contral Computer (2002)
25. Feng, Shengli: Shengdiao yudiao yu hanyude jumo yuqi [Tone, Intonation, and Chinese SFPs]. Yuyanxue conglun,1:28 (2015)
26. Ji, Zhuanzhuan, Yan, Jingting: Tangshan fangyan yuyin he yudiao de shiyan fenxi [Experimental analysis of phonetics and intonation in Tangshan dialect]. Tangshan shifan xueyuan xuebao,40.01:5-9 (2018)
27. Qi, Jianying: Jingzhouren xuexi putonghua yao zhuyide jige wenti [Some problems that Jinzhou people should pay attention to in learning Mandarin]. Liaoning jiaoyu xingzheng xueyuan xuebao, 09:75-77 (2007)
28. Zhu, Xiaodan: Nanjing fangyan yuqici yanjiu [A studyof modal particles in Nanjing dialect]. Doctoral thesis, Qingdao University (2011)