

PHONETIC MANIFESTATION AND INFLUENTIAL FACTORS OF PRONOMINAL ANAPHORIC WORD “TA” IN CHINESE READING TEXTS

Luying Hou^{1, 2} Yuan Jia¹

¹Institute of Linguistics, Chinese Academy of Social Sciences, Beijing, China

²Institute of Linguistic Studies, Shanghai International Studies University, Shanghai, China

ABSTRACT

The present paper conducts a pioneering exploration on the phonetic manifestation and of *pronominal anaphora* and influential factors in Chinese reading texts, taking the third personal pronoun “ta” as example. The F_0 and duration of “ta” of varied types are compared; also, the stress degrees of “ta” and its surrounding syllables are examined. The results demonstrate that: i) syntactic position plays a prominent role in the phonetic manifestation of “ta”; ii) the stress pattern of “ta” and its surrounding syllables reflects the prosodic integration of “ta” in its current sentence and the interactive relationship between syntax and prosody; iii) textual level, information structure, emotion, focus and individual characteristics can all be factors that accounts for the phonetic variations of “ta” and the disparities of the stress pattern between “ta” and its surrounding syllables.

Index Terms— Prenominal anaphora, third personal pronoun, Chinese reading texts, F_0 , stress, duration

1. INTRODUCTION

As an essential phenomenon in texts, *anaphora* is widely researched by linguists. It is the coreference of an expression with a previous component. According to Ping Chen [1], anaphora in Chinese can be categorized into three types, i.e., zero anaphora, pronominal anaphora and nominal anaphora. Many researchers have investigated *Chinese textual anaphora* in the syntactical [2], pragmatical [3], rhetorical [4] and cognitive perspectives [5]. However, few studies have dealt with Chinese anaphora via phonetic approach; therefore, its phonetic feature remains much unknown.

For this reason, the present study aims to investigate anaphora in Chinese reading texts from the phonetic point of view, exclusively focusing on pronominal anaphora. The third person singular pronoun “ta” is concerned for its higher frequency in textual materials. In Chinese, there are three third person singular pronouns, i.e., “他” (he) for male, “她” (she) for female, and “它” (it) for the non-humans. Despite the orthographic disparities, their pronunciations are the same. Moreover, the lexical tone of “ta” is the high and level tone H-H, the first tone in modern Mandarin. Featuring a

narrow pitch range (0 theoretically) and a flat pitch contour, it is a typical steady tone in Mandarin; therefore it is ideal for analysis and observation. This study endeavors to answer the following questions: i) what are the phonetic manifestations of “ta” at varied syntactic positions; ii) what is the contribution of “ta” to the prosody of its current sentence; iii) what are the influential factors for the phonetic manifestation of “ta”?

2. METHODOLOGY

Phonetic analysis is adopted to approach the research goal. The differences among pronominal anaphoric word “ta” at varied syntactic positions are compared; also the stress patterns of “ta” and its surrounding syllables are examined.

2.1. Materials

The materials selected in the study are reading texts. There are ten texts chosen from the Annotated Speech Corpus of Chinese Discourse (ASCCD), which was developed by the Phonetic Lab, Institute of Linguistics, Chinese Academy of Social Sciences (CASS). The texts cover common genres such as narration, argumentation, news report and essay. The phonetic data were collected from ten Standard Mandarin speakers (five male and five female) in Beijing. The annotation was based on C-ToBI system and the annotation files include four tiers. In the current research, the stress tier (ST) was used for analysis, in which four stress degrees (0 means weak, 1 means normal, 2 means secondary stress and 3 means primary stress) of each prosodic unit were annotated.

2.2. Research Design

The study first labeled the anaphoric word “ta” occurring in seven different syntactic positions in the 10 texts, i.e., i) subject “ta” at paragraph-initial position (P1), at sentence-initial position following a period (P2), and at sentence-initial position following a comma (P3); ii) possessive pronoun “ta” followed by a noun at sentence-initial position (P4) and preceding the possessive particle “de” at sentence-medial position (P5); iii) *concurrent word* (*Jianyu in Chinese*) “ta” at sentence-medial position (P6); iv) object “ta” at sentence-final position (P7). In this categorization, P1

– P4 are at the sentence-initial position, P5 and P6 are at sentence-medial position, while P7 is at sentence-final position. In this research, F_0 , duration and stress degree are taken as parameters to investigate the phonetic manifestations and the influential factors of “ta”. The materials contain 3 cases of P1, 3 cases of P2, 9 cases of P3, 4 cases of P4, 1 case of P5, 4 cases of P6 and 1 case of P7. Table 1 shows the examples of the seven types of “ta” concerned in the study.

Table 1. Examples of Seven Types of “Ta”

P1	她 (P1) 试着 做过 小 买卖, <i>she tried did small business</i> She (P1) tried to do small business.
P2	他 (P2) 认为, <i>he think</i> He (P2) thought that
P3	孙庆福 兄 妹 7 个, <i>Sun Qingfu brother sister 7 (a measure word)</i> 他 (P3) 是 老 大。 <i>he is old big</i> Qingfu Sun has 6 siblings; he (P3) is the eldest.
P4	她 (P4) 丈夫 在 民航 系统 工 作, <i>her husband at civil aviation system work</i> Her (P4) husband works in the aviation administration.
P5	露出了 他 (P5) 的 “盒子 炮”, <i>showed out his (possessive particle)mauser pistol</i> He exposed his (P5) “mauser pistol”.
P6	看 他 (P6) 动了 真 格, <i>see he moved real</i> I saw that he (P6) became serious.
P7	宋素梅 不 嫌弃 他 (P7) , <i>Sumei Song not dislike him</i> Sumei Song didn't reject him (P7),

2.3. Data Annotation and Extraction

Based on the pronominal labeling in the texts, a fifth anaphora tier in the annotation files was added, in which the pronominal information was annotated. The following information was extracted: i) ten F_0 points of each vowel in P1 - P7 (therefore the normalization of syllabic duration is achieved); ii) the duration of P1 - P7; iii) the stress degree of P1 - P7; iv) the stress degree of the syllable immediately following P1 - P6 (P7 is at the sentence-final position); v) the stress degree of the syllables preceding P5 and P6 at sentence-medial position. Praat 4.6 was used for annotation and extraction, SPSS 19 was employed for statistic analysis.

3. PHONETIC ANALYSIS OF “TA” AT VARIED SYNTACTIC POSITIONS

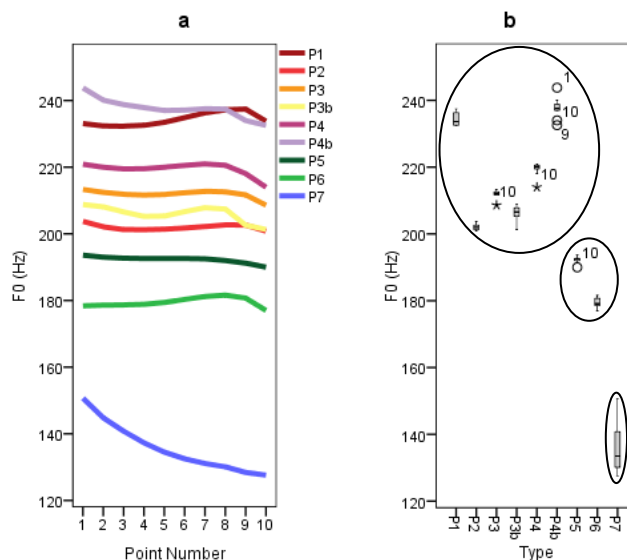
This section compares the F_0 and duration of “ta” at varied syntactic positions, with the aim to investigate the syntactic influence on the acoustic features of “ta”. For P3, there are

two cases in which the emotion factor is involved; and for P4, there is one case in which “ta” is the contrastive focus. These cases are singled out as P3b and P4b for separate analysis.

3.1. Contrastive Analysis of F_0

Figure 1 shows the mean F_0 contours and their distribution of “ta” of varied types of the ten speakers.

Figure 1. F_0 Contours of Varied Types of “Ta”



From Figure 1 and statistic analysis, the following observations can be obtained:

First, the F_0 contours can be roughly divided into three sets: i) P1, P2, P3, P3b, P4, P4b, which are at sentence-initial position, constitute the upper set; ii) P5 and P6, which are at sentence-medial position, compose the middle set; iii) P7, which is at sentence-final position, forms the lower set. Paired t-test was further conducted to examine the differences among the three sets. The lowest F_0 contour (P2) in the upper set, the F_0 contours in the middle set and the F_0 contour of the lower set are compared. The results are illustrated in Table 2: the F_0 of “ta” at sentence-initial position is significantly higher than that at sentence-medial position, which is in turn significantly higher than that at sentence-final position. The result shows a staircase F_0 pattern that “ta” at different syntactic positions behave differently.

Table 2. Paired T-test between P2 & P5, P6 & P7.

Pair	P2 - P5	P6 - P7
t	30.516	16.653
df	9	9
Sig.	0.000	0.000

Second, for “ta” at sentence-initial position, Figure 2a shows that the F_0 contour of P1, which is at paragraph-initial position, is higher than that of P3, which is at sentence-

initial position following a comma, and it is in turn higher than that of P2, which is at the sentence-initial position following a period. Table 3 shows the differences are significant. However, the pattern that the F_0 of P2 is lower than that of P3 is a little confusing, which will be discussed later.

Table 3. Paired T-test among P1, P2, and P3.

Pair	P1 - P2	P1 - P3	P2 - P3	P2 - P3
t	55.383	31.798	-35.046	10.889
df	9	9	9	9
Sig.	0.000	0.000	0.000	0.000

Third, for P7 at sentence-final position, the F_0 contour is not only the lowest; it also has an obvious downward tendency. These tendencies may reflect the phonetic integration of “ta” when in a sentence context.

The F_0 patterns show that the pitch of “ta” greatly correlates with its syntactic position. Its F_0 is the highest when at sentence-initial position and is the lowest when at sentence-final position. This “high-medium-low” pattern and the downward tendency of P7 reflect the boundary tone influence and the attenuation effect of the glottal vibrating frequency when uttering a sentence. Moreover, the significant differences among “ta” in three types of sentence-initial positions can reflect the textual level of a sentence.

3.2. Contrastive Analysis of Duration

Table 4 shows the mean durations of “ta” of different types. The duration of P1 is relatively longer than that of P2 and P3, indicating the textual level of its current sentence can also be reflected by duration. P4 has the shortest duration, reflecting the integration of “ta” and its following component into a larger syntactic and prosodic unit. The duration of P6 is also relatively long, its peculiar syntactic role may account for it, for it serves as both the object of the preceding verb and the subject of the following verb. P7 has the longest duration, which may also reflect the boundary effect.

Table 4. Durations of Varied Types of “Ta”.

P1	0.1614
P2	0.1445
P3	0.1478
P3b	0.1847
P4	0.1416
P4b	0.1659
P5	0.1500
P6	0.1587
P7	0.2060

4. “TA” AND TEXTUAL PROSODY

It is noticed that the stress degrees of “ta” and post “ta” syllable have different combinative patterns. This study concerns four major patterns, i.e., i) w-s (weak-strong),

which means the stress degree of “ta” is lower than that of the following syllable; ii) s-w (strong-weak), which means the stress degree of “ta” is higher than that of the following syllable; iii) w-w (weak-weak), which means the stress degrees of “ta” and the following syllable are both 0; iv) s-s (strong-strong), which means the stress degrees of “ta” and the following syllable are both 1, 2 or 3. The four patterns can be further divided into two general patterns: asymmetrical (w-s & s-w) and symmetrical (w-w and s-s). The percentages of different patterns for each type of “ta” are calculated, which are shown in Table 5. P7 is excluded for it is at the sentence-final position.

Table 5. Percentages of Four Stress Patterns for “ta” and post “ta” syllable

	w - s	s - w	w - w	s - s
P1	33.3	53.3	6.7	6.7
P2	26.7	50	20	3.3
P3	24.3	41.4	24.3	10
P3b	80	10	0	10
P4	76.7	13.3	3.3	6.7
P4b	10	70	0	20
P5	0	70	30	0
P6	57.5	15	27.5	0
All	39.2	31.6	18.4	10.8
All	70.8 (asymmetrical)		29.2 (symmetrical)	

4.1. Stress Degree Pattern Analysis for Different Types of “Ta”

For different types of “ta”, the following observations can be obtained:

- For subject “ta” P1, P2 and P3, the percentages of s-w pattern are much higher than that of w-s pattern, which reflects subject “ta” at sentence-initial position tends to be accented.
- For possessive pronoun “ta” P4, 76.7% adopts the w-s pattern, reflecting the information structure of the current sentence: “ta” is the known information while post “ta” component is the new information.
- For possessive pronoun “ta” P5, 70% adopts the s-w pattern, which is the innate pattern of “ta de”, for “de” is always de-accented.
- For P6, 57.5% adopted the s-w pattern, which may also reflect the information structure. Moreover, Prosodic integration of the whole sentence may also account for the preferred pattern, which will be discussed in detail.
- For P3b and P4b in which the emotion and focus factors are involved, the stress patterns are reversed compared with P3 and P4, which will be discussed later.

The results demonstrate that “ta” of different syntactic functions have distinct preferred stress combinative patterns; information structure, innate prosody, emotion can all be factors that can influence the preference of stress pattern.

4.2. Overall Stress Degree Pattern Analysis

Table 5 shows 70.8% of “ta” and post “ta” syllable prefer the asymmetrical stress combinative patterns. This metrical feature of “ta” and post “ta” syllable reflects the “Relative Prominence Principle” [6] and accounts for the melodious feature of the Chinese reading materials. It also reflects the prosodic integration into a sentence, which can be illustrated by P6.

The mean of the stress degree of P6 and the syllables before and post P6 (bP6 and pP6) for each subject are shown in Figure 2a. Figure 2b is the contrastive illustration of mean distributions for all the subjects. The result of Paired t-test among P6, bP6 and pP6 in Table 6 shows that the stress degree of pP6 are significantly higher than that of P6 ($p=0.030$), and the stress degree of bP6 has a high tendency than that of P6 ($p=0.054$), forming an “s-w-s” pattern.

P6 serves as the object of the preceding verb as well as the subject of the following verb. The object “ta” tends to be de-accented (60% of P7’s stress degree are 0 and 40% are 1), but the subject “ta” tends to be accented which is illustrated in Table 5, so there arises a confliction between “w” for “ta” as object and “s” for subject “ta”. What’s more, P6 is the given information and should also adopt “w”. According to the principle of Optimality Theory [7], prosodic integration happens in the way that “ta” adopts the “w” feature, then the preferred “s-w” pattern for “ta” and post “ta” syllable changes into “w-s” pattern, achieving a harmonious alternant “s-w-s” pattern. This phenomenon is like the “iambic reversal rule” [6] and the “rhythm rule” [8].

The asymmetrical stress pattern reflects the interaction of syntax and textual prosody, and embodies the predominating influence of syntax on prosody and the modulatory effect of prosody.

Figure 2. Mean Distribution of Stress Degree of bP6, P6 and pP6.

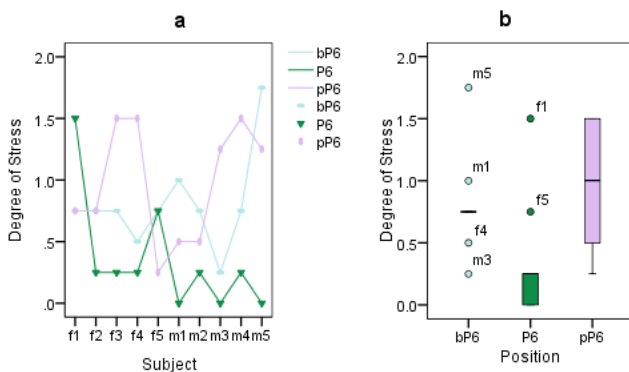


Table 6. Paired T-test of Stress Degree among bP6, pP6 and P6.

pair	bP6 - P6	pP6 - P6
t	2.212	2.580
df	9	9
Sig.	0.054	0.030

5. INFLUNENTIAL FACTORS ANALYSIS

This section investigates the factors that may influence the phonetic manifestation of “ta”. As mentioned before, P3b and P4b are singled out for separate analysis. The mean stress degrees of “ta” and the first following syllable of each speaker are calculated. Also, the F_0 and durations of “ta” and the stress pattern of “ta” and post “ta” syllable in different conditions are compared.

5.1. Emotional Factor Analysis

Table 7 illustrates the two cases of P3b in which emotion factor is involved. The mean stress degrees of P3 and P3b are compared, as well as those of the post P3 and P3b syllables (pP3a and pP3b). Figure 3a shows the means of the stress degree of P3, P3b, pP3 and pP3b for each subject, while Figure 3b illustrates the contrastive mean distribution of the 10 subjects. Table 8 shows that the differences between P3b&pP3b, P3&P3b, pP3&pP3b are significant ($p < 0.05$).

Table 7. Examples of “ta” with Emotion Factor

P3b	它 (P3b) 震撼着 每一个人的 心。
	<i>It shocks everyone's heart</i>
	It (P3b) shocks everyone's heart.
	它 (P3b) 绝 不 是 一只 荒野中的 孤 狼。
	<i>It absolutely not is a in wild alone wolf</i>
	It (P3b) is absolutely not a lonely wolf in the wild.

Figure 3. Mean Distribution of Stress Degree of P3, pP3, P3b and pP3b.

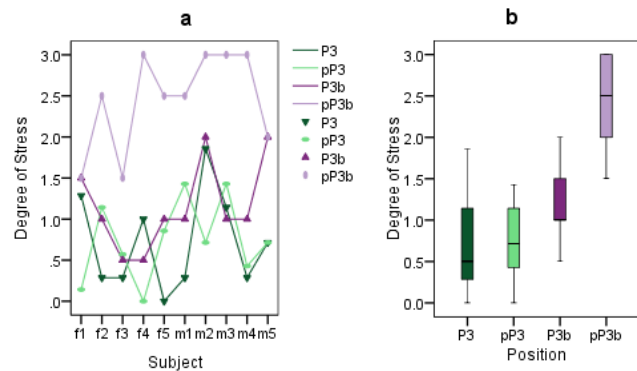


Table 8. Paired T-test among Mean Distributions of Stress Degree of P3, pP3, P3b and pP3b.

Pair	P3 - pP3	P3b - pP3b	P3 - P3b	pP3 - pP3b
t	-1.06	-4.993	-2.531	-7.894
df	9	9	9	9
Sig.	0.918	0.001	0.032	0.000

The result shows:

- A) The stress degrees of “ta” has an upward tendency and that of post “ta” syllable is raised significantly ($p < 0.01$) and the duration of “ta” (Table 4) is lengthened when emotion factor is involved.
- B) The contrast between “ta” and post “ta” syllable is significantly enhanced by emotion factor.
- C) The “s-w” pattern is more preferred in the normal condition while the “w-s” pattern is highly preferred in emotion condition (Table 5), showing the emotion is conveyed by post “ta” syllable.

5.2. Focus Factor Analysis

Table 9 illustrates the case of P6b in which “ta” is the contractive focus. Figure 4a shows the mean stress degrees of P4 and the post P4 syllables (pP4), as well as the individual stress degree of P4b and post P4b syllables (pP4b), for there is only one case of P6b. Figure 4b demonstrates the contrastive mean distribution. Table 10 shows the results of paired t-test among P6, pP6, P6b and pP6b. The results exhibit significant differences between following comparative pairs, i.e., P6 & pP6, P6b & pP6b, P6 & P6b, pP6 & pP6b ($p < 0.05$).

The result shows:

- A) The stress degree of “ta” is raised and the duration (Table 4) is lengthened when “ta” is the contractive focus, while the stress degree of post “ta” syllable is dramatically reduced.
- B) The contrast between “ta” and post “ta” syllable is reversed by focus factor: the “w-s” pattern is preferred in normal condition while “s-w” pattern is preferred, indicating “ta” is contrastive focus.

Table 9. Examples of “Ta” as Contractive Focus

P4b	三家人 合 住 一套
	<i>Three families together live a suit of</i>
	Three families lived together
	三 居室 的 单元房,
<i>three bedroom (adjective particle) apartment</i>	
in a suit of apartment with three bedrooms,	
她 (P6b) 家 住 的	
<i>Her family live (adjective particle)</i>	
The room in which her (P6b) family lived	
这 间 最 大,	
<i>this (a measure word) most big</i>	
was the biggest.	

Figure 4. Mean Distribution of Stress Degree of P4, pP4, P4b and pP4b.

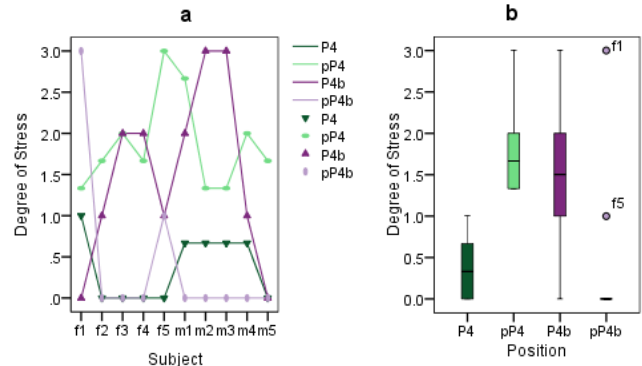


Table 10. Paired T-test among Mean Distributions of Stress Degree of P4, pP4, P4b and pP4b.

Pair	P4 - pP4	P4b - pP4b	P4 - P4b	pP4 - pP4b
t	-6.007	-4.993	3.973	1.941
df	9	9	9	9
Sig.	0.000	0.001	0.003	0.084

4.3. Individual Variations

The exceptions in Figure 3 and 5 illustrate that individual characteristics is another important influential factor of the phonetic manifestation of “ta”. Speakers f3 and f5 tend to accent concurrent word “ta” and post “ta” component when “ta” is the contrastive focus, which contradicts to the overall preference of other speakers. The stress patterns of “ta” and post “ta” syllable also reflect the individual preferences, e.g. in the 7 cases of P3, speaker f1 adopted one “w-s” pattern and six “s-w” pattern, while speaker m1 adopted 4 “w-s” patterns and one “s-w” pattern.

5. DISCUSSION

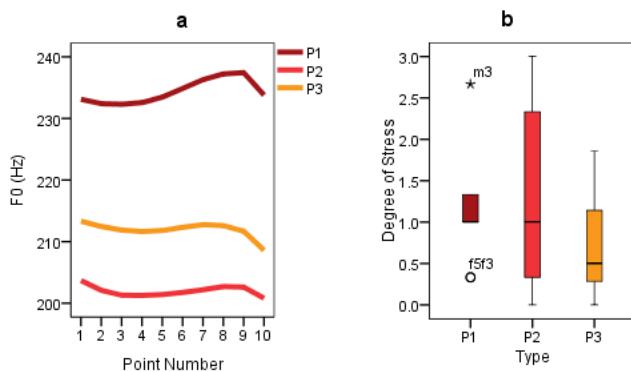
The study investigates the phonetic manifestation of pronominal anaphora and its influential factors in Chinese reading texts, taking the third personal pronoun “ta” as example. Several aspects that may introduce errors should be stated here. First, due to the textual material, the numbers of cases for each type of “ta” are not consistent and certain types of “ta” only have one case. The second problem is that the accuracy and consistency of stress degree annotation, which was done based on perception [9].

Another phenomenon that needs noticing in this study is the inconsistency of F_0 and stress degree. For “ta” at sentence-initial positions, Figure 5a illustrates the F_0 of P2 is significantly lower than that of P3; however, Figure 5b shows the tendency that the stress degree of P2 is higher than that of P3, although the difference hasn’t reached significance ($p=0.099$). Also, the mean of stress degree of P2 (1.333) is higher than that of P3 (0.714) to a large extent.

This phenomenon is also observed in the case of P3 and P3b. From Figure 1, the F_0 of P3 is higher than that of P3b, but Figure 3 shows the tendency that the stress degree of P3b is higher than that of P3, although the difference hasn't reached significance ($p=0.099$). Also, the mean of stress degree of P2 (1.15) is higher than that of P3 (0.714) greatly.

This inconsistent pattern shows that although F_0 is a predominant parameter in the stress perception in Chinese, there can be other factor involved in the stress perception [9]. Duration and the prominence of the following component may be the potential influential factors. It may be inferred that in certain circumstances the perception of stress can rely more on other aspects than F_0 in Chinese. On the other hand, the relatively small number of cases and individual characteristics may also account for the statistic disparity: the contradictive patterns “w-s” and “s-w” were not divided for separate statistic analysis with the consideration that the individual disparities can be balanced by the calculation of the mean of all the speakers. Therefore, further study is needed to investigate this phenomenon.

Figure 5. Mean Distribution of Stress Degree of P4, pP4, P4b and pP4b.



Despite the potential influential factors in the random materials and the varied styles of the 10 speakers, the results we obtained exhibit an overall significantly consistent pattern. The observations in the study can lead to a further understanding of pronominal anaphora from phonetic point of view and the relationship between speech and prosody.

6. CONCLUSIONS

Through contrastive phonetic analysis, the present study explores the phonetic manifestation and influence of zero anaphora in Chinese reading texts. The following conclusions can be inferred based on the results: i) syntactic position plays a prominent role in the phonetic manifestation of “ta”; and the textual level of a sentence can also influence the phonetic manifestation of “ta” at sentence-initial position; ii) the stress pattern of “ta” and its surrounding syllables reflects the prosodic integration of “ta” in its current sentence and the interaction effect of syntax and prosody,

namely, syntax can influence the phonetic manifestation of “ta” is influenced by syntax and can also be modulated by prosody; iii) information structure, emotion, and individual characteristics can all be factors that accounts for the phonetic variations of “ta” and disparities of the stress pattern between “ta” and its surrounding syllables. We hope this research could contribute to the research of the interface of phonetics, phonology and syntax, the prosodic expressions of Chinese texts and speech synthesis.

7. ACKNOWLEDGEMENTS

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