

# Acoustic Manifestations of Information Categories in Standard Chinese

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## Abstract

*The present study mainly investigates the acoustic manifestations of various information categories in Standard Chinese (hereinafter, SC). Results of experiments have demonstrated that rheme focus, theme focus, rheme background and theme background can be reflected by different acoustic realizations. Specifically, rheme focus and theme focus can induce  $F_0$  and duration prominences, and the former exerts more obvious variations. Although rheme background and theme background introduce no prominences, the former can be manifested by greater magnitude of acoustic performances than the latter.*

**Key Words:** *Information category, rheme focus, theme focus, rheme background, theme background*

## 1. Introduction

Information transmission and exchange is a cooperative activity between at least a speaker and a listener. Its primary function is to effect changes in pragmatic information among speakers (Dik [1]). In pragmatics, information is generally classified into two major categories: *Given* (or *Old*) vs. *New*. This tradition can be traced back to Prague School, where *new information* is defined as ‘information that the addressor believes is not known to the addressee,’ and *given information* as information ‘which the addressor believes is known to the addressee’ (Brown and Yule [2]). In phonological aspect, Steedman [3] classifies the information into four categories, i.e., a primary distinction between *theme* and *rheme*<sup>1</sup>, a secondary distinction between *focus* and *background*, further, he distinguishes *rheme-focus*, *theme-focus*, *rheme-background* and *theme-background*, respectively.

In previous literatures, acoustic manifestations of rheme focus and theme background are usually distinguished, i.e., Xu [5][6] investigates  $F_0$  variations induced by rheme focus in SC and English, and he proposes that rheme focus exerts obvious effect on  $F_0$  range expansion in under focus

position and  $F_0$  range compression in post-focus position. Chen [7] investigates the prosodic realization of information categories in SC and she proposes that both  $F_0$  and duration are adjusted to signal information variations. Taking duration as the parameter, Jia et al [8] examine the durational adjustment by the *five-syllable* focused constituents in SC and point out that when the word dwells in the rheme focus domain, every syllable is lengthened significantly in comparison with the constituent in theme background condition.

From the overview of the previous studies, it is important to note that previous analysis mainly discusses the acoustic manifestation in one information dimension, that is, the acoustic distinction between *rheme focus* and *theme background*. Therefore, the present study employs the definition of Steedman [3] and investigates the acoustic manifestations of multiple information categories in SC, i.e., *rheme focus*, *theme focus*, *rheme background* and *theme background*, with the aim to explore the acoustic mechanism speakers employ to express different types of information in SC.

## 2. Method

Acoustic experiment is adopted to achieve the research goal, specifically, in the experiment,  $F_0$  and duration are taken as the parameters to examine the acoustic variations induced by different information categories in SC.

### 2.1. Materials

Two central concerns determine the choices of the syntactic components for the target sentence: (i) the attempt to allow for the most informative comparisons among the sentences in various information categories; (ii) the effort to build natural sentence that could come up in every conversation and involve as little phonetic repetition as possible. To accomplish (i) and (ii), the following syntactic components are selected as the samples: Subject={Liu2Min2(Liumin)}; Verb={Ti2Ba2 (elevate)}; Object={Mao2Lan2(Maolan)}.

The above constituents are composed in linear sequence as ‘SVO’ which is considered to be the

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<sup>1</sup> The terms *theme* and *rheme* are taken from Mathesius [4].

common and unmarked word order in SC (Xu [9]). Thus, the sample sentence is listed in (i):

(i) Liu2 Min2 Ti2 Ba2 Mao2 Lan2 Le0.

*liu min elevate mao lan le*

(Liumin elevated Maolan).

In the experiment, different categories of information are achieved from *wh*-question equivalents being placed in the preceding position of the target sentence in order to elicit the production of utterances with the following readings: a *rheme background reading*, a *rheme focus reading*, a *theme background reading* or a *theme focus reading*. These four categories, together with the context that trigger them, are presented in examples “a-d”. In “a” and “b”, the syntactic item ‘Subject(Liumin)’ is rhematic items, once background in “a”, and once focus in “b”; whereas, in “c” and “d”, the ‘Subject’ bears thematic information, either background in “c” or focus in “d”. In contrast with the four information categories of ‘Subject’, the ‘Object(Maolan)’ only obtains two kinds of categories, e.g., rheme focus and theme background, however, differences among the rheme focuses of object constituents in context “a”, “c” and “d” are due to its corresponding information categories on subjects. The *wh*-operators together with the carrier sentences are presented in following (a)-(d):

(a) Fa1 Sheng1 Le0 Shen2 Me0 Shi4?(What happened?)

Liu2 Min2 Ti2 Ba2 Mao2 Lan2<sup>[+RF]<sup>2</sup></sup> Le0.

S V O<sup>3</sup> Le0  
 { } { }  
 background focus  
 { }  
 rheme

(b) Shei2 Ti2 Ba2 Mao2 Lan2 Le0? (Who elevated Maolan?)

Liu2 Min2<sup>[+RF]</sup> Ti2 Ba2 Mao2 Lan2 Le0.

S V O Le0  
 { } { }  
 focus background  
 { } { }  
 rheme theme

(c) Liu2 Min2 Ti2 Ba2 Shei2 Le0? (Liumin elevated whom?)

Liu2 Min2 Ti2 Ba2 Mao2 Lan2<sup>[+RF]</sup> Le0.

S V O Le0  
 { } { }  
 background focus  
 { } { }  
 theme rheme

(d) Liu2 Min2 Ti2 Ba2 Shei2 Le0? Shei2 Ti2 Ba2 Shei2 Le0? (Liumin elevated whom? Who elevated whom?)

Liu2 Min2<sup>[+TF]</sup> Ti2 Ba2 Mao2 Lan2<sup>[+RF]</sup> Le0.

S V O Le0  
 { } { } { }  
 focus background focus  
 { } { } { }  
 theme theme rheme

## 2.2. Recording

All the above *asking-answering* pairs were involved in the recording schema. Totally eight SC speakers, four females and four males, aged within 20-45, were invited to participate in the recording. These subjects were divided into four groups, each contains two women or two men. The recording was conducted in the sound-proof booth in the CASS<sup>4</sup>. During the recording, each *wh*-question and target sentence pair appeared on the screen in totally random order. One subject was asked to read the *wh*-questions and the other reads the target sentences as the answer to the questions in normal speed without any irregular pause. The speakers were instructed to read the sentences as naturally as possible according to the given texts. After the presentation of the materials, the subjects were asked to change the *asking-answering* role. The analysis was performed on the tokens produced by all the eight speakers. Therefore, for each sentence the study obtained 32 samples.

## 3.3. Data analysis

The syllable content of all the obtained “wav” files was annotated by automatically labeling program. Then, the boundaries of the syllables were double checked manually to ensure the accurate of the data. F<sub>0</sub> and duration data were obtained from “PitchTier” and “TextGrid” files and SPSS 10.0 was adopted for statistical analysis. One-Way ANOVA was further employed to examine the significances of differences in pitch value and duration of each syntactic component in various information categories.

## 3. Acoustic manifestations of various information categories

This part mainly deals with the acoustic realization of different information categories in SC. Within the account of phonetic nature of information category, it is important to consider the following aspects: (i) the

<sup>2</sup> “RF” is the abbreviation of rheme focus and “TF” is for theme focus.

<sup>3</sup> S, V and O are taken to stand for subject, verb and object, respectively.

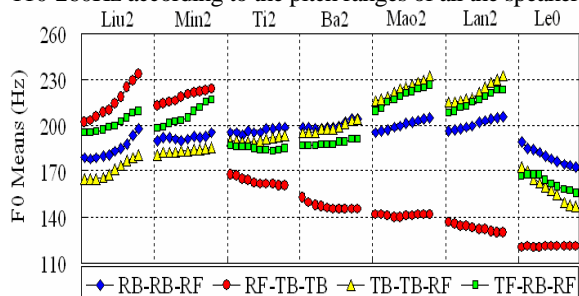
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physical correlates of prominence bearing unit, also the pre-prominence and post-prominence constituents; (ii) the specific manner of the realization of prominences; (iii) the hierarchical level of prominences induced by different levels of information, and (iv) the phonological nature of the prominences.

### 3.1. F<sub>0</sub> pattern

As described in part 2.1, the target sentence is designed as “Liu2 Min2 Ti2 Ba2 Mao2 Lan2 Le0(Liumin elevated Maolan)” and various kinds of information are placed onto the utterance through *wh*-operators. In particular, the ‘subject’ constituent “Liu2 Min2” attains the information conditions of rheme background, rheme focus, theme background, and theme focus. With regard to the ‘object’ components, they are dwelled in rheme focus, theme background, rheme focus, and rheme focus, respectively.

The overall F<sub>0</sub> patterns of the utterances in various information categories are presented in Figure 1. Within this figure, the top part of the X-Coordinate describes the content of each syllable in the sentence, while the bottom part displays the information category of each utterance. As for each target sentence, the kind of information for each word is described by capitalized abbreviations. Specifically, ‘RB-RB-RF’ stands for the condition that the subject and verb item locate in the rheme background environment, and the object in the rheme focus condition; ‘RF-TB-TB’ indicates the information of rheme focus, theme background, and theme background distributing on subject, verb, and object constituents, respectively; as for ‘TB-TB-RF’, it is taken to indicate that the theme background, theme background, and rheme focus are placed onto the corresponding syntactic components, i.e., subject, verb and object; finally, ‘TF-TB-RF’ implies that the focus condition for each element in the sentence is theme focus, theme background, and rheme focus. The Y-Coordinate illustrates the F<sub>0</sub> range measured the unit of Hz which is selected as 110-260Hz according to the pitch ranges of all the speakers.



**Figure 1:** The Mean F<sub>0</sub> for “Liu2 Min2 Ti2 Ba2 Mao2 Lan2 Le0” in various information categories

Apparently, it can be seen from contour ‘RB-RB-RF’ in the figure that there exists no obvious intonation prominence in the contour; whereas, the *declination phenomenon* is restricted by the rheme focus on the object item. What constitutes an interesting phenomenon is that the syllables “min2,” “ti2,” and “ba2” nearly lose their *L* tone features due to tonal co-articulation. It is reported by Yip [10] that when a tone2 syllable is preceded by a tone1 or tone2 syllable, it processes tonal change from tone2 to tone1. As it is proposed by Jia et al [8] that focus exerts an effect on the restriction of tonal changes at the phonetic level to some extent, specifically, it helps a tone2 item maintain the *L* tone feature. Therefore, in the above figure, the three mentioned syllables are not affected completely by the tonal co-articulation rule. As for the contour ‘RF-TB-TB,’ the rhematic focus exerts an obvious lifting effect on the pitch register under focus, and the pitch registers of the theme background bearing unit are significantly compressed. Moreover, the tone2 syllables in the post-focus positions nearly lose their original tonal target of “LH” and perform like the level tones. Such post-focus pitch range compression is a common phenomenon in other languages such as Danish, Chinese or Japanese are among those that have been reported to reduce the pitch register on post-focal material (i.e., Xu [5][6] and Beckman and Pierrehumbert [11]). Within ‘TB-TB-RF,’ the prominence locates on the object position with the whole pitch register of the object being obviously raised. Under a double focus condition, say, contour ‘TF-TB-RF,’ the two prominences also correspond with the theme focus and the rheme focus, however, the most obvious acoustic manifestation associates with the primary information, i.e., rheme focus, and the secondary with the secondary information, i.e., theme focus.

The tonal target of the tone2 component is “LH”, and a One-Way ANOVA analysis was conducted on the minimum and maximum pitch values of each syntactic word in the sentence. As can be seen from Figure 1, in the subject position, the low point and high point of the rhematic focus constituent behaves the highest value, and the difference on the *H* tone is more obvious than the *L* tone. Thematic focus occupies the secondary position, then it is the rhematic background bearing unit and the thematic background bearing unit. As for the tone2 constituents in the mentioned information categories, the maximum pitch values also show significant differences with each other. These results indicate that the variations of information categories can be reflected in F<sub>0</sub> performances, specifically, it can be manifested from the existence or absence of prominence and the height of the pitch register of the target words. Results of results of the Bonfroni post hoc test support the above

observations. The specific values are: RF vs. TF ( $P=0.002$ ), RF vs. RB ( $P=0.00$ ), RF vs. TB ( $P=0.00$ ), TF vs. TB ( $P=0.001$ ), RB vs. TB ( $P=0.003$ ). With regard to the minimum pitch value differences of subject item “liu2min2,” RF vs. TF ( $P=0.003$ ), RF vs. RB ( $P=0.00$ ), RF vs. TB ( $P=0.00$ ), TF vs. TB ( $P=0.002$ ), RB vs. TB ( $P=0.004$ ).

As for verb constituents, the contours ‘RB-RB-RF’, ‘TB-TB-RF’, and ‘TF-TB-RF’ exhibit similar performances and it demonstrates that the double focus triggers have no compressive effect on the pitch register between the two focuses. This result also states that the rheme focus on the object position is not affected by the pitch register variation of the preceding constituents. It is worth noting that the rheme focus on the subject position exerts an obvious compressive effect on the following constituents in the contour “RF-TB-TB”, the pitch register of the verb items exhibits lower than the other three contours<sup>5</sup>.

In the object positions, although the object item “mao2lan2” exhibits two kinds of information categories, in the contours “TB-TB-RF” and “TF-TB-RF”, they both have rheme focus on object position and they exhibit no obvious differences in acoustic performances. However, when the subject unit is located in the rhematic background condition “RB-RB-RF”, the highest and lowest points of the object constituents exhibit differently from the other three conditions. In addition to that, the thematic background bearing constituent on object shows the lowest pitch registers. Thus, the prominence on the object constituent is not affected by the preceding theme focus on the subject<sup>6</sup>.

In summary, the differences in information categories can be reflected in the realization of  $F_0$

contour, specifically, the prominence is correlated with the focus condition. And, the most obvious  $F_0$  performance is triggered by the most important information, i.e., rheme focus, and the secondary performance lies in the effect from the theme focus. Although the rheme background and theme background can not exert  $F_0$  prominence, rheme background information can raise  $F_0$  to some extent in comparison with the theme background information.

### 3.2. Duration pattern

The  $F_0$  pattern of utterances with a rheme background, rheme focus, theme background, or theme focus reading on the subject constituents have shown that  $F_0$  prominence yields a coherent picture with the focused constituents. However, previous studies have shown that, the parameter of duration is also important to express accentuation during communication (Eefting [12]). Therefore, the major aim of this part is to deal with the lengthening phenomena, particularly with durational changes of the target words induced by various information categories, through which to investigate how the information category is manifested on duration in SC. Based on the aim, it is therefore important to consider the following two questions: (i) duration pattern variations induced by different information categories; (ii) the corresponding relationship between lengthening and  $F_0$  prominence.

Figures 2 and Figure 3 illustrate the durational patterns of subject and object constituents induced by various information categories. The X-Coordinate describes the information category of each target word in the sentence, specifically, “RB” denotes rheme background; “RF” denotes rheme focus; “TB” denotes theme background, and “TF” denotes theme focus. Y-Coordinate illustrates the durational distribution in milliseconds (ms). The range of durational changes in the ordinate axis is selected as 30-50ms based on all the duration data.

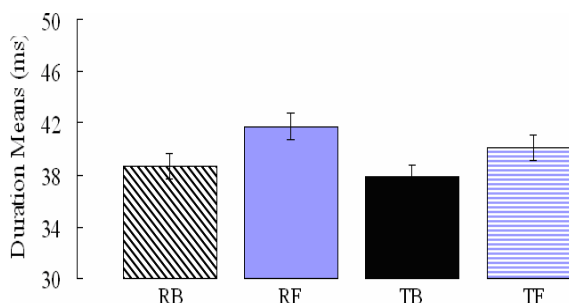


Figure 2: Mean duration for “Liu2 Min2” in various information categories

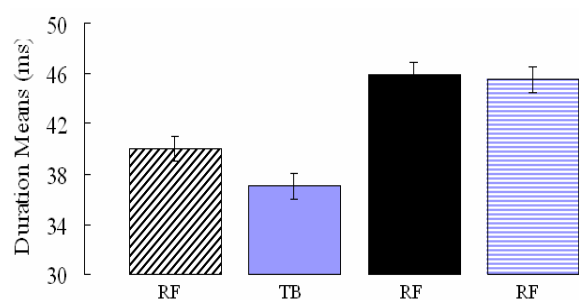
<sup>5</sup> Results of a One-Way AVONA shows that the lowest and highest of the verb constituents in contours of ‘RB-RB-RF,’ ‘TB-TB-RF,’ and ‘TF-TB-RF’ are not different from each other ( $P_{min}>0.05$  and  $P_{max}>0.05$ ). As for ‘RF-TB-TB,’ its maximum pitch and minimum pitch values are different from the previous three contours ( $P_{min}<0.05$  and  $P_{max}<0.05$ ).

<sup>6</sup> Further, results of the Bonfroni post hoc test shows that the minimum pitch values of the words “mao2lan2” in the following conditions are difference from each other:  $RF_{\text{thematic background}}$  vs.  $RF_{\text{thematic background}}$ ,  $RF_{\text{thematic background}}$  vs.  $RF_{\text{thematic focus}}$ ,  $RF_{\text{thematic background}}$  vs.  $TB$  ( $P<0.05$ ). However,  $RF_{\text{thematic background}}$  vs.  $RF_{\text{thematic focus}}$  ( $P=0.095$ ) displays no obvious differences. They are significantly different from the object constituent in thematic background condition, e.g.,  $RF_{\text{thematic background}}$  vs.  $TB$  ( $P=0.00$ ),  $RF_{\text{thematic focus}}$  vs.  $TB$  ( $P=0.00$ ). As for the maximum pitch value of the object word “mao2lan2”, they show similar results. The specific values are:  $RF_{\text{thematic background}}$  vs.  $RF_{\text{thematic background}}$  ( $P=0.001$ ),  $RF_{\text{thematic background}}$  vs.  $RF_{\text{thematic focus}}$  ( $P=0.001$ ),  $RF_{\text{thematic background}}$  vs.  $TB$  ( $P=0.00$ ),  $RF_{\text{thematic background}}$  vs.  $RF_{\text{thematic focus}}$  ( $P=0.074$ ),  $RF_{\text{thematic background}}$  vs.  $TB$  ( $P=0.00$ ), and  $RF_{\text{thematic focus}}$  vs.  $TB$  ( $P=0.00$ ).

Examination of Figure 2 shows that the rhematic focus constituent exhibits the greatest magnitude of lengthening. This phenomenon is illustrated by the second rectangle in Figure 2. The thematic focus induced lengthening occupies the secondary position, the rhematic background constituent occupies the ternary position, however, the thematic background constituent gets the least magnitude of durational change. Specific values of duration lengthening are:  $liu2min2_{RF}$ : 41.77ms,  $liu2min2_{TF}$ : 40.1ms,  $liu2min2_{RB}$ : 38.7ms, and  $liu2min2_{TB}$ : 37.8ms. Further, One-Way ANOVA was conducted to test the significance of the differences in the durational distribution among the four information categories. Results of the Bonfroni post hoc test demonstrates that the lengthening of the word “liu2min2” in various information categories are different from each other: RF vs. TF ( $P=0.001$ ), RF vs. RB ( $P=0.00$ ), RF vs. TB ( $P=0.00$ ), TF vs. RB ( $P=0.002$ ), TF vs. RB ( $P=0.002$ ), RB vs. TB ( $P=0.004$ ).

The lengthening results of subject constituents show regular patterns. As is the case with the  $F_0$  evidence, the rheme focus exerts the most obvious effect upon lengthening, and the theme focus exhibits a secondary effect on durational change. The rheme background and theme background also exhibit different patterning characteristics.

Following Figure 3 is the durational lengthening of object constituents. The bottom part of the X-Coordinate of states the information condition of the object constituent, and they are dwelling in the information category of “RB-RB-RF”, “RF-TB-TB”, “TB-TB-RF” and “TF-TB-RF”, respectively.



**Figure 3:** Mean duration for “Mao2 Lan2” in different information categories

From the  $F_0$  analysis, it can be observed that although the object constituent “mao2lan2” has two information statuses, the  $F_0$  patterns display differences among the rhematic focus due to the corresponding information condition on the subject items. It can also be determined from Figure 3 that the three rhematic focus bearing units exhibit unsymmetrical distribution. Apparently, the last

two constituents get the primary and secondary duration lengthening and the difference is not obvious. The first rhematic unit exhibits ternary lengthening while the thematic background constituent exhibits the least magnitude of lengthening. Specific durational distribution values are: rheme focus<sub>Theme background</sub><sup>7</sup>: 45.87ms, rheme focus<sub>Theme focus</sub>: 45.56ms, rheme focus<sub>Rheme background</sub>: 39.98ms, and theme background: 37.07ms<sup>8</sup>. Thus, both the graph and the specific values show that when the subject constituents are put into four kinds of information categories, they are significantly different from each other.

On the whole, the duration of object constituents are not different from each other although they exhibit two kinds of information categories on subject constituents: rheme focus<sub>theme background</sub> and rheme focus<sub>theme focus</sub>; whereas, they are quite different from another rheme focus with the subject constituent as rheme background. This result also exhibit consistent performance with  $F_0$ .

#### 4. Discussion

The present paper mainly discusses the phonetic realization of the information categories in SC. The acoustic manifestations in SC observed in the above parts have shown that the category of information can be reflected by different levels of acoustic manifestations i.e., the most important information is marked by primary prominence and the subordinated information is symbolized by secondary prominence. Consequently, the rheme focus is marked by primary prominence and the theme focus is related with secondary prominence. The two kinds of prominences can co-exist with each other in one sentence with the secondary one locating in the preceding position. On the whole, the prominence and durational lengthening results obtained in the above part have two implications: (i) dual focus information can realize double prominences in the surface form, and (ii) the two prominences have hierarchical distinctions. Therefore, it is reasonable to suggest that the level difference of prominences in SC is related to the classification of *nuclear accent* and *pre-nuclear accent*, with the former bears the obligatory and unique nature in a contour and the latter the optional and secondary

<sup>7</sup> The footnote is adopted to stand for the information category on subject constituents.

<sup>8</sup> Results of the Bonfroni post hoc test shows that  $RF_{Theme\ background}$  vs.  $RF_{Theme\ focus}$  are not significantly different from each other ( $P=0.23>0.005$ ). However, these two rhematic focuses exhibit obvious differences with other constituents; specifically,  $RF_{Theme\ background}$  vs.  $RF_{Rheme\ background}$  ( $P=0.001$ ),  $RF_{Theme\ background}$  vs.  $TB$  ( $P=0.00$ ),  $RF_{Theme\ focus}$  vs.  $RF_{Rheme\ background}$  ( $P=0.002$ ), and  $RF_{Rheme\ background}$  vs.  $TB$  ( $P=0.00$ ).

characteristics according to the intonation tradition from the British School (Crystal [13], Ladd [14], Gussenhoven [15], to list just a few). According to the founding work in the British school, Palmer [16] proposes that the contour is divided into three parts, called *head*, *nucleus* and *tail*. Only the nuclear part is obligatory, so that in a mono-syllabic utterance, the contour consists of the nucleus alone. In an utterance with more syllables, the nucleus occurs on the most prominent stressed syllable. In English grammar, Ladd [14] and Gussenhoven [15] also state that contours obligatorily consist of one accent that corresponds to the nucleus. They also state that the nuclear part may be preceded by one or more accents that are defined as pre-nuclear accents. This grammar gives us something corresponding to the term head in the British tradition.

Evidence from acoustic manifestations of various information categories have shown that SC exhibits that it contain the phonological entities of *nuclear accent* and *pre-nuclear prominences* at the sentential level. The two kinds of prominences can co-exist with each other in one target sentence, and the information category can determine the distribution of the nuclear and pre-nuclear parts: *nuclear prominence* is always related to the most important information that is described as rheme focus in this study. The secondary information, i.e., theme focus, can be suggested to determine the appearance of *pre-nuclear prominence*. However, the underlying cause for the restriction of the appearance of the nuclear prominence and pre-nuclear prominence needs to be further investigated in the future study.

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