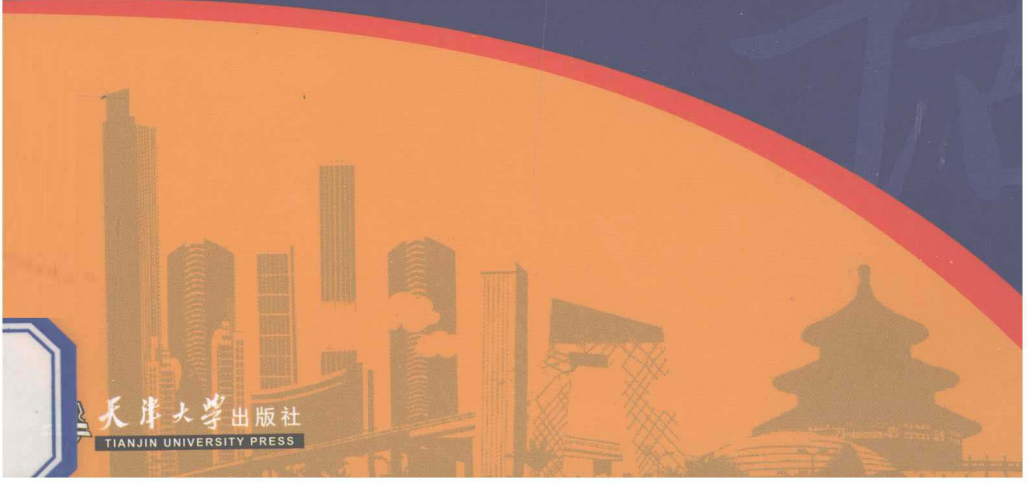
音节发音的时间结构

Articulatory Timing in Mandarin Syllables

李云靖 著



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前　言

本书以发音音系学为理论框架，基于发音数据对北京话音节中各成分发音的时间关系进行了深入的实验研究。

传统理论认为语音是按照线性依次排列的（Trubetzkoy 1939; Jakobson 1941; Chomsky 和 Halle 1968），但近来基于发音动作诸研究发现情况并不都是这样。在一个 CVC 音节中，虽然音节尾辅音是在元音结束之后才开始发出的，但音节首辅音与元音的发音却是同时开始的（Goldstein et al. 2006; Xu 和 Liu 2006）。那么，北京话音节中包括 C 和 V 在内的各成分之间存在着什么样的发音时间关系呢？北京话音节种类的数量有限，我们不妨对北京话各音节类型做一个比较全面的分析和研究，搞清楚各成分发音之间的时间关系，并提出北京话音节各成分发音动作之间的统一的音节发音模式。

发音音系学是一门基于发音动作的音系学理论，由 Browman 和 Goldstein （1986, 1988, 1989, 1992, 1995）提出。该理论认为发音动作是语言中的基本成分，音节由相互配合的发音动作构成。本书将从上述这一理论观点出发，对北京话音节各结构成分之间进行分析和探讨。

发音动作数据的采集由电磁发音仪（EMA）来完成。它可以实时显示粘贴在唇、下颚和舌面等部位表面的感应器的运动，并将这种运动与声学数据同步录制下来。发音人共有三位，均为以北京话为母语的男士，年龄均在 20—30 岁之间，没有发音和听觉上的障碍。录制下来的发音和声学数据的处理由 MatLab、Praat 等软件完成。数据统计采用 Minitab 软件完成。

北京话音节成分共有六种：音节首辅音 C、主元音 V、元音前滑音 G、元音后滑音 E、音节尾鼻音 N 和儿尾 R。这些成分可构成六对，分别是 CV、CG、GV、VE、VN 和 CR。本书的研究是采用实验方法对北京话音节各成分发音之间的时间关系进行成对比较和分析。通过实验，我们得到每对发音动作在开始时间上的差异。实验结果表明，我们进行比较的这几对发音动作均可以认为是在音节首位置同时开始实施的。调类、音节结构、发音方法等方面的不同基本上不会对数据结果产生影响。发音动作的目标位置及运动方向有时候会对相比较的两个发音动作的开始时间差带来影响，但均可以得到合理的解释。基于这一实验结果，本书提出了北京话音节组织结构模式，即：每个成分的发音均于音节首位置同时开始，然后相继结束，音节首辅音 C 首先结束，第二个是元音前滑音 G，然后是主元音 V，最后是元音后滑音 E、音节尾鼻音 N 以及儿尾 R。元音后滑音 E 与音节尾鼻音 N 不能同时出现于同一个音节之中，因此两者之间实际上并不会发生配合关系。传统理论认为的线性语音序列实际上是各个成分发音动作的结束顺序。儿尾 R 实际上是一个覆盖于整个音节上的卷舌动作。

CV 同时发音与 Goldstein et al.（2006）及 Xu 和 Liu（2006）等的主张一致。GVE 的发音同时开始相继结束与 Ren（1986）基于声学数据提出的“切割模型”（Truncation Model）类似，并能够为北京话 GVE 序列中中元音和低元音的变异及前后两个滑音不可相同的制约提供发音上的解释。基于本实验的发音动作数据，本书认为音节尾鼻音 N 与其他成分也是同时开始发音的，这虽与 Goldstein et al.（2006）及 Xu 和 Liu（2006）的主张相异，但我仍然倾向于坚持我们的意见，因为从气流动力学及共时和历时音系学方面也能够获得支持，并可以对北京话 VN 序列中元音的变异提供解释。儿尾 R 的发音与其他成分发音于音节首位置同时开始的实验结果表明儿化音节应该属于“化合

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型”，而非“拼合型”。

本书的意义主要在于，第一次对一个语言的各种音节中所有种类语音的发音时间关系进行了实验研究，并得到一个能够对多种音系学过程进行解释的统一音节发音组织模型，加深了人们对语言——尤其是北京话——音节中各成分发音时间关系及相关音系学过程的理解。

关键词：北京话；发音动作的时间关系；音节结构；发音音系学

Preface

The present dissertation makes an attempt to investigate into the articulatory timing between gestures in Beijing Mandarin syllables within the framework of Articulatory Phonology.

Speech sounds in language are traditionally believed to be linearly arranged one after another (Trubetzkoy 1939; Jakobson 1941; Chomsky and Halle 1968), but recent gesture-based studies find that this is not always the case. In a CVC syllable, while the gesture of the syllable-final consonant starts after the completion of the vowel, the gesture of the syllable-initial consonant starts simultaneously with that of the vowel (Goldstein et al. 2006; Xu and Liu 2006). This inspired me to ponder over the timing of sounds like the pre- and postnuclear glides and the retroflexion in Mandarin syllables. The limited number of all syllable types in Mandarin makes it possible to conduct an extensive investigation into the organization of elements in all types of Mandarin syllables, and to build a gesture-based model of syllable structure accounting for all intergestural timing relations in this language.

Articulatory Phonology is a gesture-based phonological theory developed by Browman, Goldstein and their colleagues (Browman and Goldstein 1986, 1988, 1989, 1992, 1995). They claim that gestures are basic elements in language, and syllables are formed by mutually coupled gestures. The questions raised in the previous paragraph will be investigated in the framework of this theory.

The technique employed for collecting the articulatory data is the electromagnetic articulography (EMA), which can perform real-time display and recording of the movements of up to twelve sensors attached

to the surface of the lips, the jaw and the tongue, and synchronized acoustical data. The participants invited are three male native Beijing Mandarin speakers all in their twenties without any speaking or hearing problems. The articulatory and acoustical data are processed by computer software MatLab and Praat. The statistical work is done by Minitab.

Totally there are six kinds of elements in Mandarin syllables, including syllable-initial consonants (C), prenuclear glides (G), nuclear vowels (V), postnuclear glides (E, from "ending", distinguished from G), nasal codas (N) and the retroflexion (R). The timing relationships between six pairs of gestures, including CV, CG, GV, VE, VN and CR, are investigated. The onset-to-onset lags of these pairs are computed. Results show that these pairs can all be assumed to start simultaneously from the beginning of the syllable. By integrating these intergestural timing relationships together, we can propose an overall model of gestural organization in Mandarin syllables, that is, all the gestures in a syllable start simultaneously form the beginning of the syllable, but end one by one differently. The initial consonant C ends first, then does the glide G, the vowel V, and at last the ending E and the retroflexion R. A postnuclear glide ending and a nasal coda are not allowed to occur simultaneously in the same syllable; so there is no coupling relationship between them. The retroflexion is actually a feature all over the whole syllable.

The coproduction of the C and V is in accordance with Goldstein et al. (2006) and Xu and Liu (2006). The coproduction of the G, V and E is in accordance with Ren's (1986) Truncation Model, and provides explanation for the variation of the mid and low vowels in GVE sequences and the prohibition of filling the two positions of glides with the same glide in the same syllable. The coproduction of the vowel and nasal coda is against the proposal of Goldstein et al. (2006) and Xu and Liu (2006), even though I will insist on the proposed model in the present

study, based on the articulatory data of the present experiment, the aerodynamic data phonological data from synchronic and diachronic phonological processes, and the explanatory power of the present model on the variation of the vowels in VN sequences. The co-onset of the initial consonant C and the retroflexion R tells us that the retroflexion is better to be viewed as a feature on the whole syllable, but not a suffix to the end, similar to the "fusional type" proposal in earlier analyses.

The primary significance of the present study is that it is the first time the timing relationships between the productions of all kinds of elements in syllables of a language are investigated in an articulatory experiment, and an integrated model of syllable structure, which is explanatory to a lot of phonological phenomena, is proposed, bringing a better understanding of the timing relationships between the productions of the elements and relevant phonological processes in syllables of the human languages, especially Beijing Mandarin.

Keywords: Beijing Mandarin; intergestural timing; syllable structure; Articulatory Phonology

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Chapter One Introduction

It is now widely known that syllable, the basic unit in phonology, is composed of consonants and vowels and these Cs and Vs are arranged one after another in the syllable. Such arrangement of Cs and Vs in the syllable leaves an impression that consonants and vowels in syllables are articulated one after another in time. The present title will conduct an articulatory experiment on the syllable timing in Mandarin Chinese with an attempt to discover the elemental organization of the syllable, at least in Mandarin Chinese.

1.1 Research Background

In Articulatory Phonology developed mainly by Browman and Goldstein (1986, 1988, 1989, 1992, 1995), syllable is viewed as the basic timing unit for segmental or gestural organization. In this approach, all gestures are arranged inside the domain of each syllable. As for the syllable timing, Goldstein et al. (2006) propose that in a CVC syllable, the initial C gesture and the V gesture start simultaneously from the beginning of the syllable, while the coda C gesture starts after the offset of the V gesture, and ends at the offset of the syllable. Though the data of their studies are mainly from English, the results and the model proposed are supposed to be applicable in all the world languages.

The syllable structure model proposed by Goldstein et al. (2006) is based on articulatory data. Xu and Liu (2006) propose a similar syllable structure model but their model is based on acoustical data. In the paper, they argue that syllable is the basic organizational unit for segments, and

provide evidence to show that in a CVC syllable, the initial C and V are produced simultaneously from the beginning of the syllable, and the coda C starts at the offset of the V. Xu and Liu (2006) collect their data from several languages including Mandarin, and they intend to consider their model to be applicable also to other languages.

However, evidence has shown that the organization of gestures, or at least some aspects of it, may be language specific. Gick et al. (2006) found that though there exist many language universal features, language-specific patterns, though apparently influenced by universal phonetic factors, must nonetheless, to a large extent, vary from language to language, based on articulatory data of liquids in seven languages collected by using the ultrasound imaging technique. Gao (2008) also found difference on CV onset lag between Mandarin and the general model proposed in Articulatory Phonology. In the general model proposed in Articulatory Phonology, the C and V gestures in CV or CVN syllables are considered to be articulated simultaneously with each other, while Gao argued that in Mandarin the starting time of the V gesture is a little later than that of the C gesture of CV and CVN syllables. Her explanation for this inconsistency is that the lexical tone in Mandarin plays a role in the starting time of the C gesture, therefore triggering the C-center effect (Goldstein et al. 2006). In a CCV syllable, the start of the first C gesture will move a little forward, and that of the second C gesture will move a little backward, and that of the V gesture will remain at the original position, resulting in a pattern of gesture timing that the V gesture starts at the center between the onsets of the two C gestures. The reason for the displacement of the two C gestures is that they are both in-phase coupled with the V gesture in planning, and therefore a competition arises between them, causing them to move apart from each other. This evidence shows that an overall investigation of the articulatory

syllable structure is necessary for individual languages, especially for Mandarin.

1.2 Purpose of the Study

The goal of the present study is to, based on articulatory data, build an overall model of gesture timing in Mandarin syllables.

The reason for me to favor articulatory data over acoustic data in gesture timing study is that articulatory movements of speech organs are more basic than acoustical features in understanding timing relationships between different segments or gestures. Specifically speaking, acoustic signals are the results of the movements of the speech organs, and the sound recorded has been affected by many factors such as the media of sound waves, while articulatory data obtained can present a clear and direct picture of the movements of the speech organs without any medial steps. Rebuilding gestural movement from acoustical information has been a controversial task until the present.

In Mandarin, there are totally five kinds of segmental elements, including the initial consonant, the prenuclear glide (on-glide), the nuclear vowel (vocalic nucleus), the postnuclear glide (off-glide) and the coda nasal. The retroflexion in retroflexed syllables is always considered a segmental element. In an overall model of Mandarin syllable structure, the production of these six kinds of elements should all be included and studied in detail. In addition, syllables in Mandarin can also be reduced into their corresponding reduced forms. How the gestures are arranged in reduced syllables is also taken into consideration in the present study.

Gao's (2008) claim about Mandarin syllable structure is really surprising. However, her study is not sufficient to build an overall model of Mandarin syllable structure. Firstly, the syllables included in her

speech material all take /a/ as the nuclear vowel. An investigation of the gestural timing in syllables with other kinds of nuclear vowels is necessary. Secondly, she has studied only CV onset lags, without involving all other gestures, representing other kinds of segments, such as the prenuclear glide, the post-nuclear glides and the nasal coda. The present paper will take the timing relationships between all these five gestures into consideration. Retroflexed and reduced syllables are not included in Gao's (2008) study, either; so an investigation of the gestural timing patterns in retroflexed and reduced syllables and their difference and links with the unretroflexed and unreduced syllables is also necessary.

Till now, there is no one single language in the world which has been seriously investigated in the aspect of the timing relationships between all the elements in a syllable. The number of syllable types in Mandarin is limited, providing a chance for us to make a complete investigation of the timing relations between the elements in syllables in Mandarin.

1.3 Theoretical Framework

The present study is carried out within the theoretical framework of Articulatory Phonology advanced by Browman and Goldstein (1986, 1992, 1995). In Articulatory Phonology, gestures are basic phonetic units. The variations on place and degree of gestures differentiate meanings. Based on the places and degrees of vocal tract contract, gestures can be grouped into five types. Each oral gesture has two parameters, while velar and glottal gestures each has one (Task Dynamic Model, Saltzman and Munhall, 1989). Figure 1.1 shows the gestures in Articulatory Phonology.

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