

# 行政院國家科學委員會專題研究計畫 成果報告

漢語母音研究：以聲學實驗、口語語誤及失語症語料為例  
證(3/3)

研究成果報告(完整版)

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計畫主持人：萬依萍

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## Report

One of the fundamental goals of every phonological theory is to account for the nature of the basic units of speech sounds, and the relationships between these units and their contextual variants. This relationship is equally crucial to phonological theory whether it is called ‘phonemes and allophones’, as in traditional phoneme theory, ‘underlying and surface forms’, as in generative phonology, or ‘input and output’, as in optimality theory. However, purely structural analyses of phonological systems can often produce several hypotheses regarding the phonemic inventory and its surface reflexes in any particular language, all of which are supportable by the contrast and alternation patterns of the language. Therefore, it is necessary to draw data from some other fields such as neurobiology, lexical accesses, speech production and perception for evidence regarding phonological theory.

There has been a longstanding controversy in the literature over the number of underlying vowel categories in Mandarin, and the relationship of the myriad of surface vowel forms to these phonemic categories (e.g. Chao 1934, 1968, R. Cheng 1966, C. Cheng 1973, Pullyblank 1983, Lin 1989, Wang 1993, Wu 1994 ). The reason for the continuance of this controversy is that most phonetic manifestations of vowels in Mandarin occur in a fairly narrow range of contexts, which suggests that they probably can be reduced to a smaller set of basic vowel categories. However, a standard structural analysis of the contexts in which the various vowel alternates occur allows for several different resolutions to the problem, each one of which can be motivated on the basis of theoretical and language-internal consistency. Thus if one uses strictly ‘internal’ evidence (Ohala 1986), it may be the case that this controversy cannot be definitively resolved. Furthermore, while many of these theories regarding the underlying vowel system intend to capture the basic vowel system for all dialects of Mandarin, they are for the most part based on the Beijing dialect. Thus even if the analysis adequately captures that dialect, it may be the case that other Mandarin dialects are different enough from Beijing Mandarin that they can only be accounted for by a different underlying vowel system.

The purpose of this three-year project is to bring some distributional, phonetic, and particularly psycholinguistic evidence to bear on the issue involving the underlying vowel units and their contextual variants, looking specifically at the vowel system of the dialect of Mandarin spoken in Taipei, Taiwan. Four hypotheses regarding the underlying vowel system of Beijing Mandarin have been testified from

a corpus of over 250 syntagmatic speech errors involving vowels. Those hypotheses involve the six-vowel system of C. Cheng (1973), the five-vowel system of R. Cheng (1966) and of Lin (1989), and the four-vowel system of Wu (1994).

Evidence from the speech-error study supports the following findings:

Finding #1: Thirty-eight cases involving substitution among the high vowels suggest that the high vowels [i, y, u] are separate phonemes, as shown in (1), and that the apical vowel [i] is grouped with the vowel [i], as shown in (2). In addition, no case supports the vowel [y] being underlyingly a sequence of [u] and [i].

(1) Intended Utterance (IU): :lu<sub>51</sub> tɕy<sub>51</sub> wɔ<sub>21</sub>-mən xaw<sub>21</sub> tɕin<sub>51</sub> →

deer distance us very close

Error Utterance (EU): ly<sub>51</sub> tɕy<sub>51</sub> wɔ<sub>21</sub>-mən xaw<sub>21</sub> tɕin<sub>51</sub>

‘The deer is very close to us.’ → (meaningless)

(2) IU: zən<sub>35</sub> jaw<sub>51</sub> tsi<sub>55</sub>-tsu → EU: zən<sub>35</sub> jaw<sub>51</sub> tɕin<sub>55</sub>-tsu

people need content

‘People need to be content with what they have’ → (meaningless)

Finding #2: Eighty-five errors involving the low vowels [a, ɑ] show a case in which the environment contiguous to one of these two low vowels changes, causing the vowel to shift to the other variant, as shown in (3).

(3) IU: tsu<sub>51</sub>-tɕj<sub>aw</sub><sub>51</sub> pi<sub>21</sub> sej<sub>35</sub> tow<sub>55</sub> ta<sub>51</sub> →

assistant than who much powerful

EU: tsu<sub>51</sub>-tɕj<sub>a</sub><sub>51</sub> pi<sub>21</sub> sej<sub>35</sub> tow<sub>55</sub> ta<sub>51</sub>

‘The assistant is more powerful than anyone else’ → (meaningless)

Finding #3: Sixty cases involving alternations among the low vowels [e, ə, ɔ, o, ɤ] suggest that they should be grouped within the same phonemic category, as shown in (4)-(5). Moreover, every case except one suggests that the vowel [ɛ] should be grouped with the mid vowels rather than the low vowels, as shown in (6). The counterexample is provided in (7).

(4) IU: I: t<sup>h</sup>a<sub>55</sub> nan<sub>35</sub>-sow<sub>51</sub> si<sub>21</sub>-lɤ → EU: t<sup>h</sup>a<sub>55</sub> nan<sub>35</sub>-sən<sub>51</sub> si<sub>21</sub>-lɤ

he bad-feel dead

‘He felt extremely bad’ → (meaningless)

(5) IU: twɔ55-pan51 tsɿ51-si35 → EU: twɔ55-pan51 tsow51-si35

most            this time

‘usually at this moment’ → (meaningless)

(6) IU: tsan51-tsaj51 i55-pjɛn55 → EU: tsan51-tsaj51 i55-pən55

stand in one- side

‘(People are) standing together to one side’ → (meaningless)

(7) IU: I: tʂoŋ55-tɕjɛn55 tɕjow51 ɕiŋ35 lɿ → EU: tʂoŋ55-tɕjən55 tɕjow51-ɕiŋ35 lɿ

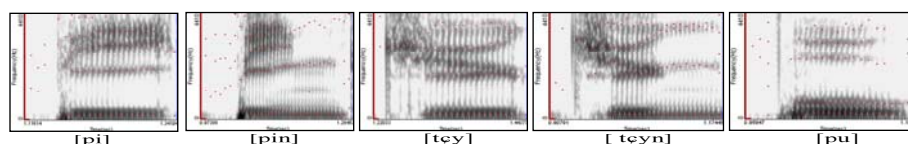
middle            just    okay

‘(putting it) in the middle is okay’ → (meaningless)

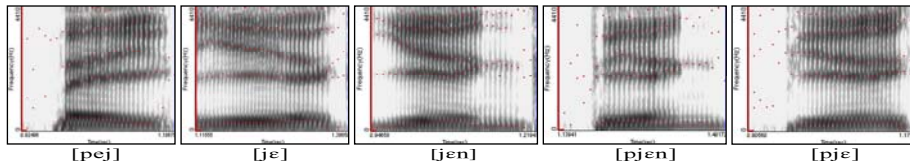
Evidence from the distributional factors and speech-error study shows that the vowel system of the dialect of Mandarin currently spoken in Taiwan cannot be accounted for any of those four hypotheses. A new five-vowel system [i, y, ə, u, a] is then proposed.

In the acoustic study in Mandarin, an analysis of the formant values in the spectrogram showed the component frequencies in the form of a sound spectrogram [i, y, u], as shown in the following.

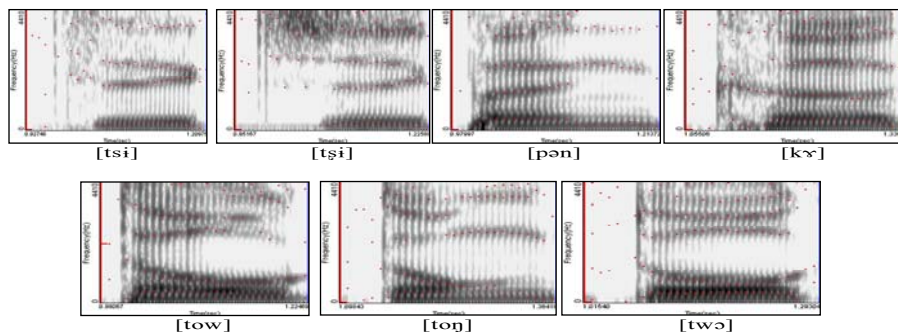
### A sample of Mandarin vowel formants



An analysis of the spectrograms shows that the steady-state vowel formants in [jɛ] are approximately F1: 605, F2: 2050, and F3: 3280; for the vowel in [jɛn] the formant values are F1: 610, F2: 2005, and F3: 3200, as shown in the following. Clearly these two vowels show no obvious phonetic differences which could be attributed to their being affiliated with different underlying vowel categories.

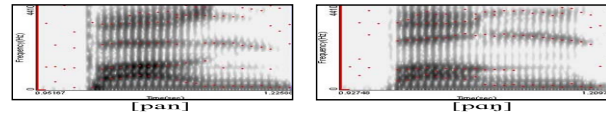


An analysis of the formant values in the spectrogram showed that that vowel following the dental onset has formant values of approximately F1: 300, F2: 2245, and F3: 3295. For the vowel following the retroflex onset the values are approximately F1: 300, F2: 2285, and F3: 3400. The first formants of the two vowels are nearly identical, and the second formants differ by 40 Hz. The third formant is about 105 Hz higher for the vowel following the retroflex consonant, showing that there is clearly no retroflexion on the vowel, since retroflexion typically causes lowering of all three formants, especially F3. Since a variation of 100 Hz is within the normal frequency variance for a formant of a single vowel, we would argue that there is no phonetic distinction between the high central vowel after dental vs. retroflex onsets in Taiwan Mandarin , and thus we notate this vowel as [i] in every case. The mid vowels in Mandarin have different component frequencies. These are shown in the following spectrogram.

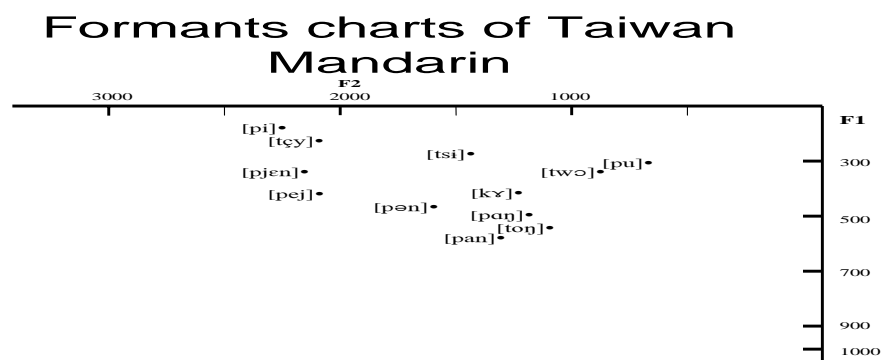


In the low vowels, in general the first formant frequency and the second formant

frequency in the first word are different from they are in the second word, as shown below.



The following lists a sample of formant charts of Taiwan Mandarin.



In aphasic study in Mandarin, so far there are only 54 errors involving vowels, and they are related to the following substitutions [i-u], [o-a], [i-y]. Most of errors are the substitutions of high vowels for high vowels, or mid vowels for high vowels. So far there has not been enough chance to support the vowel alternations in Mandarin aphasics.

In this three-year project, I looked at four such hypotheses regarding the underlying vowel system of Mandarin, all based on Beijing Mandarin: the six-vowel system of C. Cheng (1973), the five-vowel systems of R. Cheng (1966) and of Lin (1989), and the four-vowel system of Wu (1994). I then presented distributional, phonetic and psycholinguistic evidence that the vowel system of the dialect of Mandarin currently spoken in Taiwan cannot be accounted for by any of these hypotheses. Evidence from speech errors, experimental phonetics and paraphasia in Mandarin suggests a new 5-vowel system for Taiwan Mandarin, based on the distributional, phonetic, and especially the psycholinguistic facts. I conclude that phonological theories which are compatible with psycholinguistic evidence such as the data presented here are those most likely to be modeling the actual cognitive representations and processes of real speakers.

專題研究計畫國外研究心得報告

計畫主持人：萬依萍

計畫執行單位：國立政治大學語言學研究所

計畫名稱：漢語母音研究：以聲學實驗、口語語誤及失語症語料為例證

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計畫主持人於95年3月23日至4月6日期間，獲得國科會計畫赴美國紐約州立大學水牛城分校從事研究工作，並與博士論文指導教授Dr. Jeri Jaeger談及未來擬定之研究方向。於研究期間與該校華語教學及認知科學中心（如心理系、腦神經認知中心、及語言治療系等）相關學門之教授與博士生多有互動研討並參與其各項學術活動，在這兩週期間，也曾前往Ohio State University及Harvard University拜訪語言學系，並與有關學者會面切磋，並亦利用此一機會與當地學者聯絡交換研究心得。在以下幾個議題上甚有收穫：語言傳導過程模組、語音與音韻之結合、優選理論、統計與語料庫之研究、語言的經濟效益、腦神經與語言之結合性等。以下為部分之學術研究成果：

1. Wan, I-Ping. To appear. "On the phonological organization of Mandarin tone," *Lingua*. [SSCI & AHCI]
2. Wan, I-Ping. 2006a. "Mandarin speech errors into phonological patterns," *Journal of Chinese Linguistics*. [AHCI]
3. Wan, I-Ping. 2006b. "A psycholinguistic study of postnuclear glides and coda nasals in Mandarin," *Journal of Language and Linguistics*.
4. Chan, I-Chi, Jie-Fang Hu, & I-Ping Wan 2005 "Learning to read and spell: the relative role of phonemic awareness and onset-rime awareness," *Taiwan Journal of Linguistics* 3.1. 65-100
5. Her, One-Soon & I-Ping Wan Ms. Corpus and the nature of grammar: A reply to Shei. (Work on progress)