On the Status of the Prenucleus Glide in Mandarin Chinese[*]

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Prenucleus glides are traditionally classified as belonging to Final in Chinese syllables. More recently, there have been suggestions that prenucleus glides are part of Initial (Duanmu 1990, Bao 1990), and that they are part of Initial or Final depending on the places of articulation of the preceding consonants (Wan 1997). In this study, we tried to resolve the problem by administering two experiments. In the first experiment, the subjects were asked to fuse two syllables into one. In the second experiment, the subjects were asked to decide on a preferred way a syllable should be split, with two alternatives being provided for the subjects to choose from. The results showed that in both tasks the subjects preferred to classify glide with Rime. Thus, the results of our study generally concurred with the traditional treatment of classifying the prenucleus glide as part of the Final.

Key words: Mandarin Chinese, glide, rime, final, initial

1. Background of the study

Traditionally, the Chinese syllable is viewed as comprising three parts: the Initial, the Final and the Tone. The prenucleus glide, often called Medial, is traditionally classified as part of the Final, but the status has always been an issue. Chao (1931:317) presents evidence from secret languages that the Medial belongs to the Final in some dialects (e.g. Fuchou: [kwa] decomposed as [lwa-ki]), to the Initial in other dialects (e.g. Kuangchou: [kwa] decomposed as [la-kwi]), and to both Initial and Final in still other dialects (e.g. Peiping [kwa] decomposed as [kwai-lwa]). Recently, Duanmu (1990) and Bao (1990) argue on theoretical grounds that the Medial should be part of Initial, whereas Wan (1997) gathered evidence from naturalistic slips of the tongue, and conclude that a prenucleus glide sometimes acts as a part of Initial and other times as a part of Final, depending on whether the preceding consonant is anterior or posterior. In this study, we administered two experiments with a purpose to determine whether the prenucleus glide is more appropriately grouped with the Initial (the Onset) or with the Final.

## 2. Review of previous studies on the status of prenucleus glides

The structural status of the prenucleus glide in the Chinese syllable has been a controversial issue for a long time. In traditional analysis (as represented by Chao 1968:18*ff*), the Chinese syllable is divided into an optional Initial (a consonant or "zero"), a Final, and a tone. The Final in turn includes an optional Medial (prenucleus glide), an obligatory nuclear vowel and an optional ending, which can be a postnucleus glide or a consonant. The structure is schematically shown in (1) below (cf. Cheng 1973:11; see also Lin 1989:22-34).

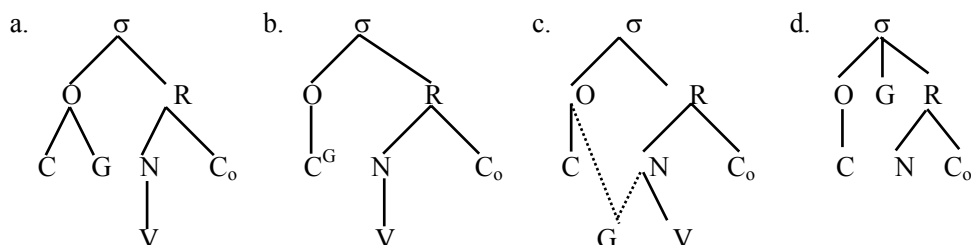(1) The traditional analysis of Chinese syllable structure

Tone			
Initial	Final		
	Medial	Rime	
		Nucleus	Ending

However, there have been suggestions in recent studies to analyze the prenucleus glide as part of a cluster with the Onset (Bao 1990; see 2a), or as a part of the Onset as a secondary articulation (Duanmu 1990; see 2b). A third hypothesis is offered by Wan (1997), who suggests that a prenucleus glide can be part of either Onset or Rime, depending on the kind of consonant preceding it. The structure is schematically shown in (2c). Still another possibility is to treat the glide as part of neither Onset nor Rime, as shown in (2d).[1]

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[1] Since we are only concerned with the status of the prenucleus glide, the internal structure of the Rime will not be dealt with in this paper. One of the reviewers suggests including another structure by Lin (1989), as in (a) below. In fact, Lin's configuration is not essentially different from the traditional analysis as shown in (1), so the analysis is not treated separately in this study. However, one may also want to consider another configuration as in (b), opted for by Bao (1990), although it was proposed for Taiwan Min. For our purpose, (b) is not different from (1) either, because the analysis treats Glide as part of the Rime. For the same reason, another possible configuration as in (c) is also not differentiated.
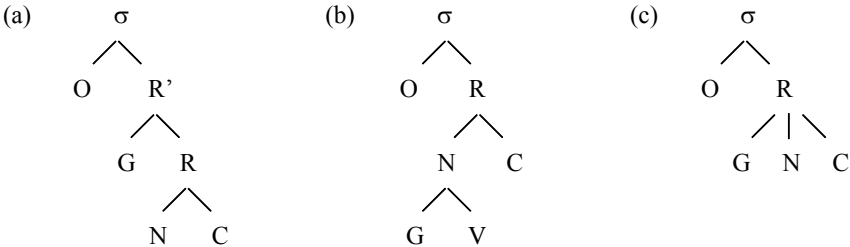
(2) Recent analyses of Chinese syllable structure

a.
```
          σ
        /   \
       O      R
      / \    / \
     C  G   N   Co
            |
            V
```
b.
```
          σ
        /   \
       O      R
       |     / \
       C G  N   Co
            |
            V
```
c.
```
          σ
        /   \
       O      R
       :     / \
       C    N   Co
        \  / \
         G   V
```
d.
```
        σ
      / | \
     O  G  R
     |    / \
     C   N   Co
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where: σ = Syllable, O = Onset, R = Rime, C = Consonant, G = Glide, V = Vowel, N = nucleus, and C_o = Coda

Bao (1990) presents evidence from secret languages (Chao 1931) and argues for the structure in (2a). Thus *lja* 'two' should be analyzed as *lj-a* rather than as *l-ja*, giving rise to the May-ka language as *ljɛ-tɕja*, Mey-ka language as *lej-kja*, and Man-t'a language as *ljɛn-tʰja*.

Duanmu (1990), on the other hand, gives six arguments for his analysis of the glide as a secondary articulation. First, there is no phonetic evidence to show that Mandarin prenucleus consonant and glide are two segments. By analyzing the glide as a secondary articulation, he is able to represent the syllable structure with three X slots, occupied respectively by C, N and C_o. Second, on the basis of a secret language from the Chengdu dialect, a prenucleus glide is replaced together with the Onset consonant by *n*. Thus, *twei* 'correct' becomes *nej-twej*, and *njaŋ* 'goodness' becomes *naŋ-njaŋ*. Third, based on acoustic evidence, the prenucleus glides in Mandarin are neither a tone-bearing unit nor a syllabic vowel, and thus should be part of the Onset. Fourth, the Mandarin nucleus vowel has a closer link with the postnucleus glide than with a prenucleus glide, since the mid vowel assimilates to the postnucleus glide when both prenucleus glide and postnucleus glide are present, as in *tjow* 'to throw' and *twej* 'team' (cf. *tje* 'saucer' *two* 'many' and *tow* 'bean' *tej* 'should'). Fifth, if the prenucleus glide is taken as part of the Onset consonant, correspondences between Mandarin and other Chinese dialects can be more easily accounted for. For example, the Santai dialect in Sichuan shows an interchange between *f-* and *xw-*: where Mandarin has *f-*, Santai has *xw-*, and vice versa. Thus, where Mandarin has *xwei* 'ashes', Santai has *fei*; where Mandarin has *fej* 'to fly', Santai has *xwej*. Sixth, two syllables rhyme in Chinese poetic works if they have the same nucleus and coda. The Onset consonant and the prenucleus glide have no role in rhyming.

For our purpose, the structures in (2a) and (2b) are not distinguishable. Both these structures regard the prenucleus glide as part of the Onset, as opposed to the traditional treatment that regards the glide as part of the Rime.

Based on the evidence from speech errors, Wan (1997) found that a prenucleus glide sometimes clusters with the Onset, and sometimes with the Rime, depending on the place of articulation of the preceding consonant and the nature of the glide itself. When the prenucleus glide is preceded by an anterior consonant, such as a labial, dental, or retroflex consonant, it is structurally part of the Rime, as evidenced by the example *tʰoŋ35-ɕɥɛ35 toŋ55-pan51* (the intended expression being *tʰoŋ35-ɕɥɛ35 twɔ55-pan51* 'most classmates', where *wɔ → oŋ*). Whereas when the prenucleus glide is preceded by a posterior consonant, such as a palatal or velar consonant, the glide forms a cluster with the Onset, as in *kwɔ51 kwoŋ55* (the intended expression being *kwɔ51 toŋ55* 'pass the winter', where *t → kw*). However, if the glide is syllable-initial, glides [j/ɥ] and [w] exhibit asymmetrical behavior. The syllable-initial glides [j] and [ɥ] are likely to associate with the Rime, while the syllable-initial glide [w] is likely to associate with the Onset. Chao's (1931:317) characterization of Peiping with regard to the secret language data (cf. Section 1) may carry such a structure, although the dotted lines in (2c) mean *either-or* for Wan, and *both* for Chao.

In (2d), the glide is an immediate constituent of the syllable, and is on a par with Onset and Rime.[2] So far we have not seen this structure opted for by linguists, and as such, no evidence is provided for such a structure. It is nonetheless listed as a possible candidate.

Faced with these different analyses of the status of prenucleus glides, the present study administered two experiments to test whether the glide should be grouped with Onset or with Rime, or with both Onset and Rime, or with neither Onset nor Rime. The two experiments are the *fanchie* and the *anti-fanchie*.

3. The *fanchie* experiment

This experiment followed the *fanchie* 反切 practice in Chinese phonology. In *fanchie*, two syllables are fused into one to annotate the pronunciation of the target syllable. For example, the pronunciation of the syllable (character) 妥 is annotated as 他果反, meaning to take the Initial consonant from the first syllable 他 [tʰa1], which is [tʰ], and to take the Final and the tone from the second syllable 果 [kuo3], which is [uo3]. Putting these elements together, one arrives at the pronunciation [tʰuo3], which is the pronunciation for the syllable 妥.

In this experiment, we asked the subjects to fuse two syllables, and see what the

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2 One of the reviewers comments that if a glide is not part of a Rime, it does not necessarily belong to the Onset. If the glide belongs neither to Onset nor to Rime, the structure should look pretty much like (2d).

outcome would be. So this was an experiment of the production type.

The predictions of the experiment are: If the traditional analysis is true, then the subjects should fuse the syllables using the Onset of the first syllable, and the glide and the Rime in the second syllable. If the structures in (2a) and (2b) are correct, then the subjects should fuse the syllable using the Onset and the glide of the first syllable, and the Rime of the second syllable. If the structure in (2c) in the sense of Chao (1931) is true, then we should expect the subjects to use the glide in the fused syllable, whether it is in the first syllable or the second syllable. In the case where both syllables have glides, the subject should choose the glide randomly. If the structure in (2c) in the sense of Wan (1997) is true, then we should expect the subjects to use the glide in the second syllable when the preceding consonant is anterior, and to use the glide in the first syllable when the preceding consonant is posterior. If the structure in (2d) is correct, then the subjects should choose the glide randomly.

3.1 Subjects

Twenty-five students from the Foreign Languages and Literature Department in National Chiao Tung University voluntarily enrolled in this experiment. Subjects ranged from monolingual to bilingual. However, all of them use Mandarin often at school and at home, and thus have near-native command of Mandarin. The subjects were tested individually in a quiet room.

3.2 Stimulus materials

In this experiment, the subjects were asked to blend two syllables into one. There were a total of 51 items, among which five were practice items, 28 were test items, and 18 were control items (for a list of the items, see Appendix I). These items were presented orally by playing an audiotape. At the same time, the subjects faced a sheet of paper on which instructions were printed. Also printed were the stimulus items written in Mandarin Phonetic Symbols (注音符號) to help the subjects identify the syllables to be blended.[3] Because in Mandarin Phonetic Symbol annotations, the glides (ㄧ, ㄨ, ㄩ respectively) are written independent of the Onset and the Rime (e.g., *tian* is annotated as ㄉㄧㄢ), this orthographic device should not have biased the subjects' responses toward Onset or Rime. The tones of the two syllables to be fused were kept the same in each item.

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[3] The reason we chose Mandarin Phonetic Symbols instead of traditional characters was because we did not want to evoke in the subjects unnecessary semantic associations that might affect the results.

Of the five practice items, one was constructed without prenucleus glides in the key syllables, while two were constructed with ー or ㄨ in the first syllable and two with ー or ㄨ in the second syllable, as shown in (3). As shown in the parentheses, these ー and ㄨ actually represented vowels in the respective syllables. The exemplary answers of the four practice items were of two kinds. One preserved the ー or ㄨ (3b and 3c), and the other removed ー or ㄨ (3d and 3e). Since each comparison appeared once in each presentation order, the effects of the preference bias should have been balanced out.

(3) a. ㄉㄞ ㄏㄢ → ㄉㄢ   (*taj*55 *xan*55 → *tan*55)
     b. ㄒ一ㄥ ㄓㄣ → ㄒ一ㄣ   (*ɕiŋ*55 *tʂən*55 → *ɕin*55)
     c. ㄗㄠ ㄉㄨㄥ → ㄗㄨㄥ   (*tsaw*55 *tuŋ*55 → *tsuŋ*55)
     d. ㄈㄤ ㄊ一ㄥ → ㄈㄥ   (*faŋ*55 *tʰiŋ*55 → *fəŋ*55)
     e. ㄘㄨㄥ ㄅㄠ → ㄘㄠ   (*tsʰuŋ*55 *paw*55 → *tsʰaw*55)

Of the 28 test items, 12 items were constructed with prenucleus glides either in the first input syllable or the second input syllable, with four items in Tone 1 (55), four in Tone 2 (35), two in Tone 3 (214) and two in Tone 4 (51). The other 16 items were constructed with prenucleus glides in both input syllables ([j] vs. [w] or [j] vs. [ɥ]), four in each of the four tonal categories. Due to the phonotactic constraints, the glide [ɥ] was not used for those items with only one prenucleus glide in the input syllables.

Among these 28 test items, nine of them contained exactly the same two input syllables as the other nine items, with the orders of the syllables in the pairs reversed. For example, the syllables *ljan maw* in one item was presented as *maw ljan* in another item. They made up 18 items. These items included all of the 12 items in which one of the input syllables contained a prenucleus glide, but not the other (see above). In this way six items had syllables with prenucleus glides in the first position, and six in the second position. Of the other six items, three had syllables with [j] in the first position and three with [ɥ] in the first position. The remaining eight items all contained [j] in one syllable of the pairs and [w] in the other syllable, among which 4 items had [j] in the first syllable and 4 had [w] in the first syllable. There were also two other items with [j] in the first syllable and [ɥ] in the second. These two items were not paired with the corresponding [ɥ~j] items.

The 18 control items were designed in such a way that none of the input syllables had prenucleus glides. The purpose of these control items was to make sure that the subjects were following the instructions in the experiment.

The stimuli for *fanchie* experiment were read onto a tape by a female native speaker of Taiwan Mandarin. The five practice items were presented in the order as shown in (3), whereas the 46 test and control items were randomized. The subjects were asked to combine the two stimulus syllables into one in each item, following the examples in the

practice items. Each stimulus item was read twice. Then the experimenter paused the tape recorder for the subjects to give the answer orally. The answers were recorded in another tape recorder for the experimenter to check later. The whole experiment lasted about 10 to 15 minutes.[4]

3.3 Results of the *fanchie* experiment

The subjects' responses to the control items were examined to see if they followed the instructions in doing the test. All 25 subjects obviously understood the purpose of the experiment and were able to combine, for example, *taj xan* into either *tan* or *xaj*. Hence data from all these 25 subjects were considered valid by this standard, and were entered for analyses.

The subjects' responses to the test items were tabulated according to the way the prenucleus glide was grouped. The subjects' responses were grouped into three types: the Onset answers, the Rime answers, and the indeterminate answers. For example, if the subject combined the input syllables *xwan laj* as *xwaj*, the response was considered an example of Onset answer. On the other hand, if the subject gave *xaj* as the answer, it was regarded as a Rime answer. There were also some cases in which the subjects combined *ljaw kwan* as *lan*. These responses followed neither the Onset principle nor the Rime principle, and are regarded as "indeterminate." In some other cases the subjects combined the Onset of the second syllable and the Rime of the first syllable, instead of the required Onset of the first syllable and Rime of the second syllable. However, in these cases the Onset or Rime answers were still clear, and they are scored as such. For example, the expected answer for *xwan laj* is either *xaj* (the glide *w* being in the Rime) or *xwaj* (the glide in the Onset); but an answer *lwan* by a subject clearly shows that he/she treated *w* as belonging to the Rime, and an answer *lan* shows that he/she treated *w* as belonging to the Onset. And these answers are scored accordingly.

Table (4) shows the tabulated results of these answers. As can be seen, the number of Rime answers in this experiment are more than two times that of the Onset answers.

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[4] One of the reviewers argues that the experiments tested only the relationship between the glide and the onset, and not between the rime and onset as we claimed. This argument is valid if the syllable has only a linear structure, rather than a hierarchical structure as one of those in (1) and (2). If the structure is hierarchical as in (1) and (2), then if the glide is grouped with the nucleus, it should belong to the constituent to which the nucleus belongs.

(4) Number of responses according to type

Types of response	Number	Percentage
Onset	202	29%
Rime	465	66%
Indeterminate	33	5%
Total	700	100%

Chi-square tests were done to compare the number of outputs made with Onset answers, Rime answers, and indeterminate answers. The result showed the number among the three types of answers yielded a highly significant difference ($\chi^2 = 406.28$, $p < 0.01$). The difference between Rime and Onset answers was also found to be significant ($\chi^2 = 103.7$, $p < 0.01$). Therefore we conclude that Rime answers were the most preferable, followed by Onset answers, and then indeterminate answers.

These statistics were examined more closely from the possible influencing factors of the type of consonants before the glide, and the type of glide itself. Table (5) shows the number of the types of answers made to these items, which are grouped according to the consonants before the glides.

(5) Number of answers according to the place of articulation of preceding consonant

	Anterior									**Posterior**				
	Bilabial			**Alveolar**				**Retroflex**		**Palatal**			**Velar**	
	p	pʰ	m	t	tʰ	n	l	tʂ	tʂʰ	tɕ	tɕʰ	ɕ	k	x
Onset	16	15	2	16	6	7	29	18	5	8	14	31	18	17
Rime	8	10	23	78	64	17	78	7	20	16	36	67	7	34
Indeterminate	0	0	1	7	5	1	16	0	0	0	2	1	0	0

According to Wan (1997), the prenucleus glide should cluster with Rime when the preceding consonant is bilabial, alveolar or retroflex, and with Onset when the preceding consonant is palatal or velar. However, we did not find such to be the case in the statistic analyses comparing this Anterior/Posterior dichotomy.

As for the other factor, that of the type of the glide itself, we did not find significant differences either. The only significant difference we could find was when there was only one prenucleus glide in the two syllables and when the syllable was in the first position. Table (6) shows these results.

(6) Number of answers for various positions of prenucleus glides

	Onset answers	**Rime answers**	**Indeterminate answers**
[j] ~ ø	47 (63%)	26 (35%)	2 (2%)
[w] ~ ø	50 (67%)	25 (33%)	0
ø ~ [j]	5 (7%)	70 (93%)	0
ø ~ [w]	8 (11%)	67 (89%)	0
[j] ~ [w]	18 (18%)	69 (69%)	13 (13%)
[j] ~ [ɥ]	31 (25%)	89 (71%)	5 (4%)
[w] ~ [j]	13 (13%)	75 (75%)	12 (12%)
[ɥ] ~ [j]	30 (40%)	44 (59%)	1 (1%)
Total	202 (29%)	465 (66%)	33 (5%)

In this table, the number of Onset answers exceeds that of the Rime answers only in the first two rows.[5] The items in these two rows had either [j] or [w] in the first syllable, and no glide in the second syllable. For example, $p^h jan\ t^h aw$ were joined as $p^h jaw$ and $kwaŋ\ ts^h aj$ became $kwaj$. Obviously, the subjects were using the strategy to preserve the glide. This tendency can also be observed in the next two rows where the glides occurred only in the second of the input syllables. Whereas the Rime answers are about 33-35% of the total answers in the first two rows, the Onset answers are only about 7-11% in the third and fourth rows. In comparison with these two percentages, the Onset answers are about 13-40% of the total answers in the next four rows. That is, the Onset answers in these four rows are intermediate between the items in rows one and two on the one hand, and rows three and four on another. Thus, we argue that the relatively small differences in the first two rows are the result of the conflict between these two tendencies: the glide-preservation tendency resulted in the high Onset answers, but the Rime tendency kept the Rime answers in these items to about 34%. And the large differences in the third and fourth rows are the result of the coincidence of these two tendencies.

Therefore, from the *fanchie* experiment we tentatively conclude that the subjects preferred to cluster the prenucleus glide with the Rime, although there was also a tendency to preserve the glide when there was only one in the two syllables. It seems,

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[5] All comparisons showed significant difference except the [ɥ] ~ [j] row, where, although the number of Rime answers exceeded that of Onset answers, the difference was not significant ($\chi^2 = 2.65$, $p > .10$). We are not able to explain such nonsignificance at this point.

then, that the structure in (1)[6] is to be preferred. The places of articulation of the preceding consonant did not seem to matter either, and Wan's (1997) analysis was not supported. The choice was not made randomly, as the chi-square statistics show, hence the interpretation in (2d) should be ruled out.

4. The *anti-fanchie* experiment

Besides the *fanchie* experiment described in the previous section, we ran another experiment, which we call *anti-fanchie*. In this experiment, the subjects were asked to choose from two alternatives to break up a syllable. In one of the alternatives, the prenucleus glide clustered with Onset, while in the other, it clustered with Rime.

Similar to the predictions of *fanchie* experiment, we expect the subjects to choose the Rime alternative if the Rime analysis as represented by (1) is adopted, and choose the Onset alternative if either of the structures in (2a) and (2b) is adopted. We expect the choice to be random if structure (2d) or (2c) in Chao's sense is true. Finally, if Wan's analysis is correct, then we expect the subjects to choose the Rime alternative when the preceding consonant is anterior, and choose the Onset alternative when the preceding consonant is posterior.

4.1 Subjects

The 72 subjects in this study were students recruited from two Freshmen English classes and one Sophomore English Writing class at National Tsing Hua University. The subjects' ages ranged from 17 to 20, and they were monolingual to trilingual. Though some subjects' native language was not Mandarin, all of them had native-like command of the language.

The subjects were tested in groups. They were divided into two order groups so that each order of presentations had a comparable number of subjects. Group 1 had 35 subjects, while Group 2 had 37 subjects. These groups differed only in the order of presentation of the items. One group had the reversed order of presentation of the other group.

4.2 Stimulus

In this experiment, there were altogether 39 items, 3 of which were practice items and the other 36 were test items. The practice items are listed in (7).

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[6] And those in footnote (1), for that matter.

(7)　1. ㄉㄢ → ㄉㄞ ㄏㄢ　　　　tan55 → taj55 xan55
　　　2. ㄒㄧㄣ → ㄒㄧ ㄓㄣ　　　　ɕin55 → ɕi55 tʂən55
　　　3. ㄗㄨㄥ → ㄗㄠ ㄅㄨㄥ　　　tsuŋ55 → tsaw55 tuŋ55

These practice items were designed in such a way that the first item did not involve any glides, and while the glides ㄧ and ㄨ in the second and the third items may look like glides, they are actually vowels in the respective syllables. The inclusion of ㄧ and ㄨ is to prepare the subjects for these symbols in the test.[7]

In each item, an input syllable was given, followed by two pairs of syllables, representing two ways the syllable could be broken into two. In one way, the prenucleus glide moved with the Onset, while in the other way it moved with the Rime. For example, the two possible ways for the syllable *njow* to be broken into two were *nian tow* and *nan tjow*. In the first of these pairs, the glide [j] moved with the Onset, and in the second, it moved with the Rime.

The input syllables and their expanded choices in the items were all real syllables. The test items were divided into three groups, each group involving one of the three glides in Mandarin. The 12 test items in each group were comprised of six pairs, with each pair reversing the order of presentation of the choices. That is, the input syllable *njow* appeared in two items. On one occasion, the choices were presented as *nian tow* and *nan tjow*, in that order, while on another occasion, the choices were presented as *nan tjow* and *nian tow*. In this way, the possible order preferences would be balanced out (see Appendix II for a list of stimuli).

The stimuli items were read into an audiotape by a female native speaker of Taiwan Mandarin, and were played back to the subjects in the experiment. The 36 test items were randomized, and two tapes were made, one containing the reverse order of presentation of the other. Each item was read twice. Each subject was given an answer sheet on which Mandarin Phonetic Alphabet notations (注音符號) were given as a reference for each item. The subjects were instructed to indicate their preferred choice for each item by checking the answer on the answer sheet. The whole experiment lasted about 30 minutes.

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[7] One of the reviewers is concerned that the inclusion of ㄧ and ㄨ may bias the subjects into thinking that Rime answers are more appropriate. We do not think such to be the case, as the symbols here represented vowels, and not glides, and as symbols they are independent and gives no clue to its status as either part of the Onset or the Rime. And in the practice items, we balanced out the possible associations of the glides with either the Onset or the Rime by having the ㄧ symbol appearing in the first syllable and the ㄨ symbol appearing in the second syllable.

4.3 Results and discussion

One student from each of the order groups missed an item or two in the experiment, and their data were thus excluded from the analyses. Thus data from 70 subjects were collected: 28 females and 42 males. In tabulating the results, each Rime answer was counted as 1 point, and each Onset answer was counted as zero. Whenever there were inconsistent answers made to the two replications of an input syllable, the data from both items were deleted.

No significant difference was found in comparing the performances of the two order groups using the Rime scores ($t = 0.79$, $p > 0.4$). Hence the results of the two groups were collapsed.

The numbers and percentages of the Onset answers and the Rime answers are shown in (8). The difference was found to be significant ($\chi^2 = 94.46$, $p < 0.01$), suggesting a preference for the prenucleus glides to group with the Rime.

(8) Numbers and percentages of Onset and Rime choices

	Number	Percentage
Onset answers	586	30%
Rime answers	1350	70%
Total	1936	100%

In accordance with Wan's (1997) proposal that the status of the prenucleus glide depends on the place of articulation of the preceding consonant, another analysis was done comparing the differences in the responses made to anterior and posterior consonants before the glides. The anterior consonants used in this experiment were [p], [pʰ], [m], [t], [n] and [l], and the posterior consonants were [tɕ], [tɕʰ], [ɕ], [k], [kʰ] and [x]. The table in (9) shows the numbers of responses in these categories.

(9) Number of responses made to items with anterior and posterior consonants

Response type \ Place	Anterior	Posterior	Total
Onset	200	386	586
Rime	564	786	1350
Total	764	1172	1936

Of the 764 cases in which a prenucleus glide was preceded by an anterior consonant,

there were 200 cases (26%) in which the glide formed a unit with the Onset, and 564 cases (74%) in which the glide was part of the Rime. Of the 1172 cases in which a prenucleus glide followed a posterior consonant, there were 386 cases (33%) in which the glide formed a cluster with the Onset, and 786 cases (67%) in which the glide was structurally part of the Rime. A *t*-test comparing the Rime scores between these two places of articulation did not show significant difference ($t = 1.21$, $p > 0.2$). Therefore, from the findings of the interactions between prenucleus glides and anterior consonants or posterior consonants, Wan's conclusion to assign prenucleus glides in two different behaviors was not supported here.

To examine the interactions between prenucleus glides and the places of articulation of a preceding consonant in more detail, we investigated subdivisions under anterior consonants and posterior consonants. The table in (10) presents the distribution of the four places of articulation: bilabial, alveolar, palatal and velar, to examine the different effects on the status of prenucleus glides resulting from these four articulators.

(10) Number of responses made to items with consonants of various places of articulation

Place / Response type	Bilabial			Alveolar			Palatal			Velar			Total
	p	p^h	m	t	n	l	tɕ	tɕ^h	ɕ	k	k^h	x	
Onset	18	34	22	76	36	14	60	82	58	50	16	120	586
Rime	108	70	88	136	58	104	162	136	140	42	106	200	1350
Total	340			424			638			534			1936

In general, Rime answers outnumbered the Onset answers in all cases except [k]. A one-way ANOVA was conducted to find out if the Rime scores among the items that had Onset consonants in various places of articulation were significantly different. The result showed that there is no significant difference among the four articulators ($F = 0.99$, $p > 0.4$). Thus the different behaviors of the place of articulation of the preceding consonant were not found to be significant.

Another analysis was done to determine whether the use of the glide made a difference. The table in (11) shows such a distribution.[8]

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[8] One of the reviewer comments that the statistics shown in (11) are not convincing because one cannot tell whether 一 in ㄒ一ㄣ or ㄨ in ㄕㄨㄥ is a glide or a vowel. Such ambiguity was intended in the practice items, but in test items it was avoided, as one can see from the items listed in Appendix II.

(11) Different status among prenucleus glides

Response \ Glide	[j]	[w]	[ɥ]	Total
Onset	172	214	200	586
Rime	486	426	438	1350
Total	658	640	638	1936

A one-way ANOVA test did not show significant difference among the three glides ($F = 0.96$, $p > 0.3$) either.

Thus, from the *anti-fanchie* experiment, the conclusion is also quite clear. The subjects tended to choose the alternative in which the prenucleus glide was grouped with Rime. The choices were not random, so the structures in (2d) and (2c) in Chao's sense were not supported. No significance was found in relation to the place of articulation either, hence Wan's analysis was not supported, either.

5. Conclusion

In this study we administered two experiments to explore the status of the prenucleus glide in Mandarin syllables, addressing the following questions: Is the glide grouped with Rime, as traditionally assumed, or is it part of Onset, as Bao (1990) and Duanmu (1990) recently assume, or is it sometimes part of the Onset and sometimes part of the Rime, depending on the kind of consonant before it, as Wan (1997) assumes; or, is it possible that the prenucleus glide does not cluster with the Onset or the Rime at all? From the results of both experiments, we found that the subjects overwhelmingly preferred to group the glide with Rime, irrespective of the kind of glide and the kind of consonants used before it. Therefore we conclude that, if there is to be a unified representation for the syllable structure, the prenucleus glide is more reasonably grouped with the Rime.

Appendix I: Stimuli for *fanchie* experiment

A. Practice items
1. ㄉㄞ　ㄏㄢ　→ ㄉㄢ　　　　taj55 xan55 → tan55
2. ㄒㄧㄥ　ㄓㄣ　→ ㄒㄧㄣ　　çiŋ55 tʂən55 → çin55
3. ㄗㄠ　ㄉㄨㄥ → ㄗㄨㄥ　　tsaw55 tuŋ55 → tsuŋ55
4. ㄈㄤ　ㄊㄧㄥ → ㄈㄥ　　　faŋ55 tʰiŋ55 → fəŋ55
5. ㄘㄨㄥ ㄅㄠ　→ ㄘㄠ　　　tsʰuŋ55 paw55 → tsʰaw55

B. Test items
1. ㄉㄠ　ㄅㄧㄢ　　　　taw55 pjan55
2. ㄅㄧㄢ　ㄉㄠ　　　　pjan55 taw55
3. ㄆㄧㄢˊ　ㄊㄠˊ　　　pʰjan35 tʰaw35
4. ㄊㄠˊ　ㄆㄧㄢˊ　　　tʰaw35 pʰjan35
5. ㄇㄠˋ　ㄉㄧㄢˋ　　　maw51 ljan51
6. ㄉㄧㄢˋ　ㄇㄠˋ　　　ljan51 maw51

7. ㄏㄢ　ㄓㄨㄚ　　　　xan55 tʂwa55
8. ㄓㄨㄚ　ㄏㄢ　　　　tʂwa55 xan55
9. ㄏㄨㄢˊ　ㄉㄞˊ　　　xwan35 laj35
10. ㄉㄞˊ　ㄏㄨㄢˊ　　　laj35 xwan35
11. ㄍㄨㄤˇ　ㄔㄞˇ　　　kwaŋ214 tʂʰaj214
12. ㄔㄞˇ　ㄍㄨㄤˇ　　　tʂʰaj214 kwaŋ214

13. ㄑㄩㄢ　ㄒㄧㄝ　　　tɕɥan55 çje55
14. ㄒㄧㄝ　ㄑㄩㄢ　　　çje55 tɕɥan55
15. ㄒㄧㄢˋ　ㄑㄩㄝˋ　　çjan51 tɕʰɥe51
16. ㄑㄩㄝˋ　ㄒㄧㄢˋ　　tɕʰɥe51 çjan51
17. ㄒㄩㄝˇ　ㄑㄧㄢˇ　　çɥe214 tɕʰjan214
18. ㄑㄧㄢˇ　ㄒㄩㄝˇ　　tɕʰjan214 çɥe214
19. ㄑㄧㄠˊ　ㄉㄩㄢˊ　　tɕʰjaw35 lɥan35
20. ㄉㄧㄠˊ　ㄑㄩㄢˊ　　ljaw35 tɕʰɥan35

21. ㄉㄧㄠˋ　ㄍㄨㄢˋ　　ljaw51 kwan51
22. ㄋㄧㄠˇ　ㄏㄨㄢˇ　　njaw214 xwan214
23. ㄊㄧㄠˊ　ㄔㄨㄢˊ　　tʰjaw35 tʂʰwan35
24. ㄊㄧㄠ　ㄙㄨㄢ　　　tjaw55 swan55

25. ㄊㄨㄛ　ㄑㄧㄢ   tʰwo55 tɕʰjan55
26. ㄊㄨㄛˇ　ㄒㄧㄢˇ   two214 ɕjan214
27. ㄌㄨㄛˊ　ㄋㄧㄢˊ   lwo35 njan35
28. ㄅㄨㄛˋ　ㄇㄧㄢˋ   two51 mjan51

C. Control items
29. ㄆㄢ　ㄊㄠ   pʰan55 tʰaw55
30. ㄆㄠ　ㄊㄢ   pʰaw55 tʰan55
31. ㄏㄡˊ　ㄇㄤˊ   xow35 maŋ35
32. ㄏㄤˊ　ㄇㄡˊ   xaŋ35 mow35
33. ㄉㄢˇ　ㄏㄞˇ   tan214 haj214
34. ㄉㄞˇ　ㄏㄢˇ   taj214 han214
35. ㄓㄚˋ　ㄍㄤˋ   tʂa51 kaŋ51
36. ㄓㄤˋ　ㄍㄚˋ   tʂaŋ51 ka51
37. ㄈㄤ　ㄅㄟ   faŋ55 pej55
38. ㄅㄤ　ㄈㄟ   paŋ55 fej55
39. ㄇㄠˊ　ㄆㄞˊ   maw35 pʰaj35
40. ㄆㄠˊ　ㄇㄞˊ   pʰaw35 maj35
41. ㄇㄡˇ　ㄌㄢˇ   mow214 lan214
42. ㄌㄨˇ　ㄇㄢˇ   low214 man214
43. ㄊㄜˋ　ㄏㄠˋ   tʰɤ51 xaw51
44. ㄏㄜˋ　ㄊㄠˋ   xɤ51 tʰaw51
45. ㄉㄢˇ　ㄌㄠˇ   tan214 law214
46. ㄊㄠˇ　ㄌㄢˇ   taw214 lan214

Appendix II: Stimuli for *anti-fanchie* experiment

A. Practice items
1. ㄉㄢ → ㄉㄞ ㄏㄢ   tan55 → taj55 xan55
2. ㄒㄧㄣ → ㄒㄧ ㄓㄣ   ɕin55 → ɕi55 tʂən55
3. ㄗㄨㄥ → ㄗㄠ ㄉㄨㄥ   tsuŋ55 → tsaw55 tuŋ55

B. Test items
1. ㄋㄧㄡ→ㄋㄧㄢ　ㄊㄡ／ㄋㄢ　ㄊㄧㄡ
   njow55 → njan55 tow55 / nan55 tjow55
2. ㄆㄧㄠˊ→ㄆㄧㄢˊ　ㄊㄠˊ／ㄆㄢˊ　ㄊㄧㄠˊ
   pʰjaw35 → pʰjan35 tʰaw35 / pʰan35 tʰjaw35

3. ㄊㄧㄠˇ→ㄊㄧㄢˇ　ㄌㄠˇ／ㄊㄢˇ　ㄌㄧㄠˇ
   tjaw214 → tjan214 law214 / tan214 ljaw214
4. ㄇㄧㄢˋ→ㄇㄧㄠˋ　ㄌㄢˋ／ㄇㄠˋ　ㄌㄧㄢˋ
   mjan51 → mjaw51 lan51 / maw51 ljan51
5. ㄌㄧㄡˊ→ㄌㄧ　ㄡˊ／ㄌㄜ　ㄧㄡˊ
   ljow35 → li55 ow35 / lɤ55 jow35
6. ㄅㄧㄢˇ→ㄅㄧ　ㄢˇ／ㄅㄜ　ㄧㄢˇ
   pjan214 → pi55 an214 / pɤ55 jan214

7. ㄏㄨㄚ→ㄏㄨㄢ　ㄓㄚ／ㄏㄢ　ㄓㄨㄚ
   xwa55 → xwan55 tʂa55 / xan55 tʂwa55
8. ㄏㄨㄢˊ→ㄏㄞˊ　ㄌㄢˊ／ㄏㄞˊ　ㄌㄨㄢˊ
   xwan35 → xwaj35 lan35 / xaj35 lwan35
9. ㄍㄨㄞˇ→ㄍㄨㄤˇ　ㄘㄞˇ／ㄍㄤˇ　ㄘㄨㄞˇ
   kwaj214 → kwaŋ214 tsʰaj214 / kaŋ214 tsʰwaj214
10. ㄉㄨㄟˋ→ㄉㄨㄢˋ　ㄏㄟˋ／ㄉㄢˋ　ㄏㄨㄟˋ
    twej51 → twan51 xej51 / tan51 xwej51
11. ㄏㄨㄟˋ→ㄏㄨ　ㄟˋ／ㄏㄜ　ㄨㄟˋ
    xwej51 → xu55 ej51 / xɤ55 wej51
12. ㄎㄨㄢ→ㄎㄨ　ㄢ／ㄎㄜ　ㄨㄢ
    kʰwan55 → kʰu55 an55 / kʰɤ55 wan55

13. ㄐㄩㄝ→ㄐㄩㄢ　ㄒㄧㄝ／ㄐㄧ　ㄒㄩㄝ
    tɕɥe55 → tɕɥan55 ɕje55 / tɕi55 ɕɥe55
14. ㄑㄩㄢˊ→ㄑㄩㄝˊ　ㄌㄢˊ／ㄑㄧˊ　ㄌㄩㄢˊ
    tɕʰɥan35 → tɕʰɥe35 lan35 / tɕʰi35 lɥan35
15. ㄒㄩㄢˇ→ㄒㄩㄝˇ　ㄑㄧㄢˇ／ㄒㄧˇ　ㄑㄩㄢˇ
    ɕɥan214 → ɕɥe214 tɕʰjan214 / ɕi214 tɕʰɥan214
16. ㄑㄩㄝˋ→ㄑㄩㄢˋ　ㄐㄧㄝˋ／ㄑㄧˋ　ㄐㄩㄝˋ
    tɕʰɥe51 → tɕʰɥan51 tɕje51 / tɕʰi51 tɕɥe51
17. ㄒㄩㄝ→ㄒㄩ　ㄝ／ㄒㄧ　ㄩㄝ
    ɕɥe55 → ɕy55 e55 / ɕi55 ɥe55
18. ㄐㄩㄢˇ→ㄐㄩ　ㄢˇ／ㄐㄧ　ㄩㄢˇ
    tɕɥan214 → tɕy55 an214 / tɕi55 ɥan214

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