The Syllable in Minnan:
Making Sense of Conflicting Sources of Evidence

Bruce L. Derwing[a], H. Samuel Wang[b],and Jane Tsay[c]

University of Alberta[a]
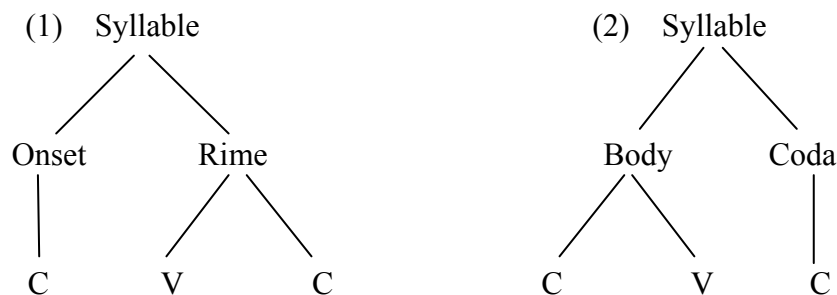*Yuan Ze University*[b]
National Chung Cheng University[c]

Internal evidence is recounted which suggests that the Minnan syllable may have a left-branching or body-coda hierarchical structure, contrary to the popular view that the syllables in all Chinese languages likely matched the traditional right-branching or onset-rime scheme of Mandarin. Four experiments are described which attempted to assess the psychological reality of this idea for native speakers. Unfortunately, the results of the first two of these experiments flatly contradicted one another, while the latter two failed to resolve the situation clearly, as well. Various possible reasons for these difficulties are discussed in detail, and the tentative decision is drawn that there is no compelling reason to think that the Minnan syllable has any kind of complex internal structure at all, but may just be treated as a single, unanalyzed whole.

Key words: Minnan, syllable structure, experiment, onset-rime, body-coda, unanalyzed whole

1. Introduction

Traditionally, Minnan (also known as Taiwanese Southern Min), like other Chinese languages, has been regarded as a language with an onset-rime syllable structure, as shown in (1) below for a CVC syllable.   Evidence for such a characterization includes rhyming in poems and songs (Chang, 1992), as well as secret languages (Li, 1985).

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(1)   Syllable                        (2)   Syllable
       /      \                              /      \
   Onset      Rime                        Body      Coda
     |        /   \                       /   \        |
     C       V     C                     C     V       C
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However, there is also evidence that a structure configuration such as (2) above, which Vennemann (1988) has named "body-coda", should also be considered for this

language.[1]   One especially compelling piece of such evidence relates to the distribution of the feature of nasality within Minnan syllables. Specifically, the nasality of the initial (onset) consonant must agree with that on the vowel, but a nasalized vowel is incompatible with a nasal coda consonant. For example, while [ban] [bat], [ba], and [mã] are all actually occurring syllables in Minnan, the sequences *[ma], *[bã], and *[mãn] are all impossible in the language (see Wang, 1995 & 2006, for more detailed accounts). Such a phonotactic constraint is quite easily and naturally described, if a syllable structure like that of (2) is involved, but not so in the case of a structure like (1). (See section 8 below for further discussion.)

The purpose of the present study was to determine whether experimental evidence could be found to bolster such internal evidence in showing that the body-coda configuration in (2) is a better characterization of Minnan syllables than the onset-rime configuration in (1), a finding that would set Minnan apart from Mandarin in this aspect of its typological characterization. In the first stage of this investigation, we tried to answer this question by administering the following two experimental tasks to native Minnan speakers: a word-pair sound similarity judgment task (Experiment 1) and a word-blending preference task (Experiment 2), as described below.

2. Experiment 1: Word-pair sound similarity judgments

In this first experiment, participants were asked to judge which of two test words was more similar to a control key word. In each test item, one of the test words shared the same body with the key word, while the other test word shared the same rime with it, as shown in the example in (3):

(3)   tan : tang[2]
        tan: pan

In this example, the key word is /tan/. The test word /tang/ shares the same body element /ta/ with the key word, while the second key word /pan/ shares the same rime /an/ with the key word.

The rationale for this experiment involves the assumption that participants will base their judgments of sound similarity on the syllable structure representations of the words

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[1] Such a structure is indicated for the Korean language (see Yoon & Derwing, 2001, for a summary of the experimental evidence involved) and, quite possibly, for the Hakka (Chinese) language, as well (Wang & Liu, 2010).

[2] Since tones are not relevant to the discussion in this study, they are omitted from many of the examples, in order to focus attention on the elements of interest.

being compared. Thus, if the structure in (1) is the correct representation, we would expect that the participants would choose the *tan-pan* pair in example (3), since these words contain a common rime; on the other hand, if the structure in (2) is correct, we would expect a preference for the *tan-tang* pair, which contain a common body. Finally, since both test words share two of three segments in common with the key word, no clear basis for choice is provided by a simple (i.e., unweighted) non-hierarchic segment model of the syllable.

2.1 Participants

One hundred and one native speakers of Minnan were recruited from four Freshman English classes (N = 23, 25 36, 17, respectively) at Tsing Hua University, Taiwan.

2.2 Procedure

There were a total of 70 items in the experiment, divided into seven blocks, with each block representing one of the seven tonal categories in the language; that is, in each block, all of the key words and test words were of the same tone. The format of presentation for each item was as shown in (4). In each block there were 8 test items and 2 control items, resulting in 56 test items and 14 control items in all. Each of the 8 test items comprised four parts, with each pair of items reversing the order of presentation of the same test words. Thus, in addition to a test item like (4), a parallel test item like (4') was also included.

(4)   tan : tang
      tan : pan

(4') tan : pan
      tan: tang

The control items were designed in such a way that one of the compared words in each pair contained either a shared body with the key word or a shared rime, while the other compared word was either identical with the key word or bore only a very remote phonetic resemblance to it. The purpose of these control items was to help us determine whether participants understood and were following the directions for the task. Since these directions stipulated that participants should choose the test word that was "more like" the first word, they should have consistently chosen the identity cases in the control

items and rejected the remotely similar ones. (See Appendix 1 for a complete list of the stimuli for Experiment 1.)

The 70 stimuli were randomized and recorded onto an audio tape. The testing was done one class at a time, with the first two classes listening to one order of presentation, and the other two classes listening to the reverse order of presentation. Each item was read twice. After hearing both readings, the participants circled "1" or "2" on their answer sheets to indicate that it was the first test word or the second that they thought was more similar to the key word.

2.3 Results

One erroneous test item was eliminated from the analysis. The results for the remaining 55 items showed an overwhelming overall preference for body-sharing answers. On average, each participant chose 42.33 body-sharing answers and 12.67 rime-sharing answers, and a paired t-test showed that this difference was highly significant (t=15.39, p<.001). Comparing the two orders of presentation, we found that the participants also tended to choose the first test word presented, regardless of its structure (t=3.78, p<.001). However, since each comparison appeared once in each presentation order, the effects of this order preference bias should have been balanced out, without affecting the overall result.

Taken by itself, this experiment seemed to support the body-coda analysis of the Minnan syllable.

3. Experiment 2: Forced-choice word-blending preference

In this second experiment, participants were asked to judge which of two new forms was preferred when two syllables were combined or blended into one. A typical test item is shown in (5):

(5)   san + tsim → sim
       san + tsim → sam

In this example, /san/ and /tsim/ are the two syllables to be combined, while /sim/ and /sam/ are the two blended forms for the participants to choose between. As can be seen in (5), /sim/ is the result of combining the onset of the first syllable (i.e., /s-/) with the rime of the second syllable (i.e., /-im/), whereas /sam/ is the result of combining the body of the first (i.e., /sa-/) with the coda (/-m/) of the second. Assuming that this choice was made on the basis of the perceived syllable structures involved, our expectation was

that a configuration such as (1) would result in a preference for onset-rime type blends, such as /sim/ in (5), whereas a configuration such as (2) would lead to a preference for choices of the body-coda type, such as /sam/.

As reported in Derwing et al. (1991, 1992), preliminary results using this technique were inconclusive for Minnan (termed "Taiwanese" at the time), as no significant difference between onset-rime and body-coda choices was found. However, about half of the test items that were included in the earlier study involved choices of the kind shown in (6), in which the order of the subcomponents in the blends did not correspond to the presentation order of these subcomponents in the two input syllables.

(6)   san + tsim → tsin
      san + tsim → tsan

In other words, participants in the first Minnan word-blending study were often forced to choose between blends that consisted of the first part of the second word presented (e.g., the body /tsi-/ or the onset /ts-/), followed by the second part of the first word presented (i.e., the coda /-n/ or the rime /-an/), which is a non-trivial task. We suspect, in fact, that this task likely proved to be so difficult that the inclusion of a large number of items of this kind may have caused many participants to essentially "give up" on the entire experiment and to begin to guess more or less randomly, leading to the finding noted. This potential defect was eliminated from the replication described here, by making the input word presentation order and the blending order the same throughout, in order that participants were always asked to choose from among blends that consisted or the first part of the first word presented, followed by the second part of the second word presented, as shown in (5).

3.1 Participants

The same 101 participants and classes who did Experiment 1 also took part in Experiment 2. However, the order of presentation within the four classes varied, with the participants in the first two classes (N=48) taking Experiment 1 first, while those in the remaining two classes (N=53) took Experiment 2 first.

3.2 Procedure

There was a total of 42 items in Experiment 2, also divided into 7 blocks, as in Experiment 1, but this time with 4 items and 2 control items in each block, or 28 test items and 14 control items in all. The format of presentation for each item was as shown

in (5). The 4 test items consisted or two pairs, with each pair of items reversing the order of the target choice forms. That is, along with a test item like (5), the test also included an item like (5'), in which the presentation order of the choices was reversed.

(5)   san + tsim → sim
        san + tsim → sam

(5') san + tsim → sam
        san + tsim → sim

The other pair of test items within each block was constructed by reversing the order of the input words in each pair. Thus, in addition to test items like (5) and (5'), there were also items such as (7) and (7'):

(7)   tsim + san → tsin
        tsim + san → tsan

(7') tsim + san → tsan
        tsim + san → tsin

Note that the input words were also balanced so that the vowels had an equal opportunity to manifest themselves within each set. Thus, in one case, the vowel /a/ appeared in the first input word, as in (5) and (5'), as well as in the second input word, as in (7) and (7'). This counter-balancing was intended to eliminate the possible effects of any specific vowel-consonant linkages.

Finally, the two control items in each block were designed in such a way that one of the choices was either a body-coda or an onset-rime combination, while the other choice was either identical to the first input syllable or else was a new word that did not contain any of the parts of the second input syllable. Again, the purpose of these control items was to gauge whether participants were following the instructions and choosing only forms that were blends of parts of both input words (see Appendix 2 for the complete list of stimuli for Experiment 2.)

The stimuli were randomized and recorded in two orders, one of which was used with two of the participant groups (classes) and the other with the remaining two classes, just as in Experiment 1. Again, each item was also read twice, after which the participants indicated their preferred choices by circling either "1" or "2" on their answer sheets.

3.3 Results

The answers from 5 of the students were excluded from the analyses. Four of these came to class late and started in the middle of the experiment, while the other gave up after answering the twenty-first item. The data used in the ensuing analyses were thus from the 96 remaining participants.

A paired t-test was done to compare the number of choices made to onset-rime answers (M = 16.47) and body-coda answers (M=11.53). The result showed a highly significant preference for the onset-rime blends (t=4.22, p<.001).[3] This result conflicted with that or Experiment 1, in which body-coda answers were preferred.

Since many participants did not perform as expected on the 14 control items, a second t-test was also run, eliminating those 47 participants who made 6 or more incorrect choices on these items (i.e., who chose answers that were not well-formed blends of either the body-coda or onset-rime types). However, a paired t-test comparing the onset-rime and body-coda answers given by the remaining 49 participants still showed a highly significant preference for the former over the latter (M= 9.16 vs. M=18.86, respectively; t=7.43, p<.001).

As in Experiment 1, there was also a significant tendency for the participants to choose the first answer presented within each pair (t=2.85, p<.01), but since the orders of presentation were again balanced, this tendency should not have affected the main result.

4. Discussion of Experiment 1 and Experiment 2

At this point we are faced with something of a dilemma, since the results of Experiment 1 seemed to support a body-coda analysis of the Minnan syllable, as shown in (2) above, while those from Experiment 2 seemed to support an onset-rime structure, as in (1). Since the same participants were involved in both experiments, such explanations as dialect, sex, and age differences were not viable. However, we did find an order effect between the two experiments. Both experiments were done in the same session within each class, but Experiment 1 was done first with the first two classes, whereas Experiment 2 was done first in the remaining two classes. Comparing these two task orders, we found that the task order had a significant influence on Experiment 1, which was the word-pair sound-similarity judgment task (t=3.07, p<.01). Specifically, the participants who took Experiment 2 (word-blending) first chose significantly fewer

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[3] In another, supplementary study (published only in Chinese), Wang (1996b) found a similar result on the basis of an experimental Pig Latin-type language game, which involved breaking Minnan syllables up into explicit onset-rime and body-coda sub-components.

body-coda answers in Experiment 1 than did the participants who did Experiment 1 (sound-similarity judgments) first. This indicates that the performance of this sub-group of participants might have been influenced by the results of the word-blending experiment in making their sound-similarity judgments. However, no such effect was found for Experiment 2, where the subjects in both task orders performed comparably (t=1.38, p>.1).

Faced with the conflicting results from these two experiments, we surmised that the results of one or both of the experiments just described were either invalid or otherwise incorrectly interpreted.[4] The following sections of this paper thus explore this line of reasoning in further detail.

5. Experiment 3: Global sound similarity judgments

One possible problem with the interpretation of the results of Experiment 1 was that the sound similarity judgments that were elicited may not have been based on the internal syllable structure of the stimuli involved. An alternative possibility is that they may have been based instead on the relative prominence of the individual sound segments that made up the syllables. There is, in fact, distributional evidence in Minnan to suggest that some segments, such as the initial (i.e., onset) consonants, may be more prominent than others, such as the final (coda) consonants. Specifically, while there are 17 possible consonants that may appear in the onset position in Minnan syllables, there are only 7 (viz., nasals and voiceless stops at the bilabial, dental, and velar positions, plus the glottal stop) that are allowed in the coda position; and of these 7 possible coda consonants, 4 of the them (viz., the voiceless stops and the glottal stop) co-occur with unique vowel tones, viz., the two so-called "entering tones" (see Cheng, 1973, for further details). In turn, the four stops in this set are all unreleased in final position, making them acoustically much less prominent than their counterparts in onset position, where information about point of articulation is preserved in the consonant release.[5]

Experiment 3 was designed to test this idea experimentally, using a global sound similarity judgment task. Specifically, participants in this experiment were asked to

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[4] The possibility that Minnan syllables might manifest variable syllable structures under different experimental manipulations was not considered as a viable option at this time, nor was the more general issue of whether hierarchical tree structures were even the best way to represent the relationships between segments within a syllable. (See section 8 for further discussion.)

[5] Thanks to James Myers for bringing this point to our attention. Furthermore, Robert Cheng mentioned to the second author that, in his attempt to teach a romanized alphabetic system to Minnan speakers, he found that many learners had difficulty in distinguishing the final consonants of Minnan words, especially the dental and velar series (i.e., /n/ vs /ng/ and /t/ vs. /k/), while they did not have much of a problem with any of the initial consonants. This supports the idea that at least some of the coda consonants are more difficult to distinguish than onset consonants, even for native speakers.

provide an overall sound similarity rating for pairs of monosyllabic words, using a ten-point scale that ranged from zero to 9. They were told that two identical words should be given a rating of 9, and that two words very different in sound throughout should be given a rating close to zero, while all other pairs should be given intermediate ratings, depending on the judged overall similarity in sound that seemed to exist between them. In accord with the previous discussion, which postulated higher weightings for initial consonants than final consonants, one of our expectations was that participants would rate those pairs with differences only in their final consonants as more similar than those that differed only in their initial consonants.

5.1 Participants

A total of 105 participants were recruited from four Freshman English classes (with class sizes equal to 24, 31, 29, and 21, respectively) at National Tsing Hua University. None of these participants took part in either Experiment 1 or Experiment 2.

5.2 Procedure

There was a total of 68 word-pairs used in this experiment, representing 12 blocks. Seven of the blocks comprised the 32 test items, with each of first six blocks providing four examples of the six patterns of segmental contrasts shown in (8), where the subscripted 1 vs. 2 indicate the positions of the segmental contrasts involved. (Each of the four sets shared a common tone throughout.)

(8) Segmental contrast patterns for the test stimuli in Experiment 3:
C_1VC-C_2VC (e.g., /tan-kan/)
CV_1C-CV_2C (e.g., /tan-tin/)
CVC_1-CVC_2 (e.g., /tan-tam/)
C_1V_1C-C_2V_2C (e.g., /tan-kin/)
CV_1C_1-CV_2C_2 (e.g., /tan-tim/)
C_1VC_2-C_2VC_2 (e.g., /tan-kam/)

The seventh test block contained eight more tightly controlled items which repeated the C_1VC-C_2VC and CVC_1-CVC_2 patterns, but where one of the words in each pair consisted of the string /lan/, which was one that readily contrasted with other strings.

The experiment also included 30 control items in four blocks, each representing one of the following types of word-pairs: (1) pairs of identical words (e.g., /tan⁵⁵-tan⁵⁵/), (2) pairs with contrasting segments in all positions but with a common tone (e.g.,

/tan^{55}-kim^{55}/), (3) pairs sharing the same segments but with contrasting tones (e.g., /tan^{55}-tan^{33}/, and (4) pairs with a mixture of segmental and tonal contrasts (e.g., /tan^{55}-kim^{33}/). The purpose of these controls was to provide a check that participants were following the instructions, as well as to test for some subsidiary effects (such as tone), which are not discussed here (see Appendix 3 for a complete list of stimuli for Experiment 3).

These test items and control items made up 62 stimuli in all. The remaining 6 items (= block 12, not scored) were selected from the other lists to represent the full range of differences represented in the test, and these were put at the beginning of the test as practice items, in order to give participants an early idea of the full range of variation to be expected throughout the experiment. Except for the six practice items, the stimuli were randomized before recording onto audiotape. A second tape was also made, in which the order of the items was the reverse of the order on the first tape. Two of the participant classes were then tested on one order, while the other two classes were tested on the reversed order. After listening to the recording of each item twice, participants then indicated their judgments by circling the appropriate number on scaled answer sheets.

5.3 Results and discussion

A linear regression analysis was run on the mean scores of the 32 test items, using the three segments in each word as variables. These three variables accounted for 85.6% of the variance in the data (r^2=.86). The results of this analysis are shown in (9).

(9) Results of the linear regression analysis for Experiment 3

Source	df	Sum of Squares	Mean Square	F
Regression	3	112.97	37.66	55.64
Residual	28	18.95	.677	

Variable	Coefficient	SE	t	p
V	4.17	.351	11.88	.000
C1	2.38	.379	6.29	.000
C2	.780	.379	2.06	.049
(Constant)	-.021	.511	-.042	.967

Of the three individual segment factors, it can be seen that the vowel (V) made the greatest contribution to the similarity scores, followed by the onset consonant (C1), as indicated by the relative sizes of their coefficients. From the significance levels, we can also see that the contributions from these two factors were both highly significant

(p<.0001). On the other hand, the coefficient of the coda consonant (C2) was relatively small, and the contribution of that factor was only marginally significant. As a matter of fact, if we remove the C2 factor from the analysis altogether, the amount of variance accounted for is still 83.5%. This result confirms our suspicion that speakers weigh the initial consonants far more heavily than the final consonants in making sound similarity judgments about Minnan syllables.

To validate this result further, we also carried out a paired comparison between the mean score for the eight C_1VC-C_2CV items (i.e., those that differed in only their initial consonants) with that for the eight CVC_1-CVC_2 items (i.e., those that differed only in their final consonants). These two means were 4.85 and 6.88, respectively, a difference that proved to be highly significant by a paired t-test (t=14.09, p<.001). This result shows explicitly that words in Minnan that differ only in their initial consonants are judged to be much less similar that those that differ only in their final consonants.

On the basis of these results, it thus seems reasonable to conclude that participants put more weight on the initial consonants of syllables than on the final consonants in making their judgments about overall sound similarities between Minnan syllables. Note further that this situation is in itself capable of producing the kind of differences that were found in Experiment 1 between words that shared common body (i.e., C1V) subcomponents and those that shared common rime (or VC2) subcomponents, without invoking the presumed higher-order constituents of these words at all. We therefore reject the results of Experiment 1 as necessarily telling us anything about the internal syllable structure of Minnan.

6. A major problem in the interpretation of the results of Experiment 2

If we had stopped our study at this point, we would be left with the conclusion that the syllable in Minnan has an onset-rime structure, much like the one presumed for Mandarin, on the basis of the word-blending data provided by Experiment 2, since Experiment 3 effectively undercuts the validity of sound similarity data from Experiment 1, insofar as its relevance to syllable structure is concerned. In this case, however, we would still seem to be faced with an uncomfortable conflict between the results of our experiment and the internal evidence provided in section 1, which seemed to indicate that a body-coda analysis was the appropriate one for Minnan. This new conflict caused us to explore the possibility that our initial interpretation of the results of Experiment 2 might also have been faulty in one or more respects.

One possible cause for concern with Experiment 2 is that word-blending, like sound-similarity judgments, might not be predicated upon syllable structure, at least not in Minnan. Hsu (2003), in fact, argues that natural syllable contraction in the language is

based instead on a sonority hierarchy among vowels, whereby the highest vowel in the ranking a > ɔ > e > o > i > u is the one that is preserved as the nucleus of the blend. As can be seen from Appendix 2, all of our stimuli involved the vowels /a/ and /i/, which appear at the almost opposite ends of this scale. If Hsu's ranking had determined the results of our experiment, however, we would have expected a preference for blends containing the vowel /a/ throughout, which clearly did not happen, as it would have led (because of the counter-balanced presentation orders involved) to a roughly 50-50 split between the two types of responses (e.g., san + tsim → sam [= body-coda blend] but tsim + san → tsan [= onset-rime]).

There is, however, another factor that most certainly complicates the interpretation of the results of our Experiment 2, and this relates to the fact that all of our participants received prior training in the use of an auxiliary orthographic system that was based on the onset-rime analysis of Mandarin, which is the language of instruction that they all know and use in school. This transcription system, known as Zhuyin Fuhao, consists of symbols that are used to represent the onset and rime components of Mandarin syllables, as illustrated in the sample shown in (10) below for the Mandarin words FAN[1] (meaning 'to turn') and HAN[1] (meaning 'to snore'):

(10) Example of the Zhuyin Fuhao writing system[6]
ㄈㄢ　　ㄏㄢ
F AN　　H AN

Since this transcription system is used in Taiwan schools throughout the first four grades, it is hard to imagine that it would not have a profound effect on the way that the speakers involved viewed the structure of the syllable in Mandarin, and perhaps also the nature of syllables in general. If there were any doubts on this score, however, these would seem to have been dispelled by the recent research done by Ch. Wang (2009), who compared the effects of learning Zhuyin Fuhao (in Taiwan) with those of learning Hanyu Pinyin (in Mainland China) on the phonological awareness of the Mandarin speakers involved. As the author concludes in his abstract (p. 1), "[T]he way in which orthography represents phonology not only has [an] effect on Chinese speakers' phonological awareness, but also has a long lasting effect on speakers' intuitions concerning the cognitive procedures [involved in making phonological judgments]."

In view of this evidence, there can be little doubt that the explicit learning of Zhuyin Fuhao by Mandarin speakers in Taiwan serves to bias their overt judgments of Mandarin syllables in the direction of an onset-rime analysis as in (1) above, but it is a priori less

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[6] No tone mark is included in this system for Tone 1 words such as these.

clear whether such a bias would also carry over to a different language, such as Minnan, for which no such transcription scheme is ever used at all.[7] Wang (1996a), however, reports that several of his participants made explicit mention of their mental reference to Zhuyin Fuhao as an aid in performing some of the segmental operations required in Minnan, providing evidence that such a transfer can, in fact, readily occur. And since the word-blending task involved in Experiment 2 presumably involved the overt identification of syllable constituents, we cannot exclude the possibility that the preference for onset-rime blends in that experiment (as well as the one that resulted from the language game in Wang, 1996b) was a consequence of exposure to an onset-rime based orthography, rather than a reflection of the covert structures internalized as part of the natural acquisition of the Minnan language itself.

Notice also that the assumption that Experiment 2 involved an awareness that Mandarin-like syllable components equivalent to Onset and Rime could be involved (which parallel the "Initial" and "Final" elements in the traditional analysis of Mandarin syllables that is taught in school) might explain the order effect noted in section 4 above. Specifically, to recap, those participants who did the syllable-blending task (Expt. 2) prior to the sound-similarity task (Expt. 1) chose significantly more onset-rime pairs in the latter task, as if the awareness that such structures might be involved had influenced their judgments.

In any event, it seems that enough questions have been raised about the interpretation of both of the first two experiments to cast doubt on the capacity of either to present unequivocal evidence in favor of either (1) or (2) as the correct representation for the syllables of Minnan, uncontaminated by the effects of irrelevant ancillary factors, such as differential segment weight or orthographic influence. It behooved us, therefore, to find yet another experimental task that was not subject to either of these effects.

7. Experiment 4: A list recall study of nonsense words in preliterate Minnan speakers

The nonsense word recall (henceforth NWR) technique was devised by the first author for use in previous work on Korean syllable structure, where issues of possible orthographic interference also arose (see Yoon & Derwing, 2001, for details). The main advantage of the approach was that it was suitable for use with preschool children who had not yet learned to read, thus eliminating the factor of orthographic knowledge altogether.

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[7] For all practical purposes, Minnan may be viewed as a spoken language that has no written representation at all, with Mandarin being used as the language of written communication within the school system throughout Taiwan.

The essence of the approach was simply to present participants with a series of short lists of monosyllabic nonsense words[8] for later recall, in some of which the words all rhymed (i.e., they all contained the same VC components), while the others contained a shared body element (i.e., CV). The basic assumption involved was that lists containing common units that were significant in the language (such as the shared rime –ET in the English nonsense words CHET, KET, HET) would be easier to remember as a set than an otherwise comparable list containing a sequence that did not constitute a significant unit in the language (such as the shared body string TE- in such nonsense words as TEM, TEK, and TENG).

As reported in Yoon & Derwing (2001), this assumption proved to hold true for a pilot study in English, as both literate and preliterate children recalled significantly more words from the rime-sharing lists than from the body-sharing lists. In the Korean study, however, just the opposite result occurred, demonstrating that several previous studies showing the predominance of the body over the rime in that language were not dependent upon the influence of orthography. Since our chief concern with the results of Experiment 2 was also the possibility of undue orthographic contamination, we developed a new version of the NWR test to use with Minnan-speaking children, as well.

7.1 Participants

A total of 40 children participated in the NWR experiment, all of whom were native speakers of Minnan. These were selected from a larger group who took both versions of a forced-choice reading test that will be described below. For the main test we chose 20 of these who qualified as non-readers on the basis of the criteria employed, plus 20 others who qualified as readers. All of the participants were pupils in a day care center located on the campus of the National Chung Cheng University, which is situated near the city of Chia-Yi, Taiwan, and all testing was carried out at that location.

7.2 Procedure

Except as indicated below, all procedures used in the Minnan version of the experiment were the same as those employed in the earlier English and Korean versions, as described in detail in Yoon & Derwing (2001).

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[8] Nonsense words were used, of course, in order to avoid the possibility of word frequency effects.

7.2.1 Materials

One problem prevented the straightforward adaptation of precisely the same technique to Minnan, however, and that was that this language utilizes so many of the possible syllable types in its inventory for real vocabulary, that an insufficient number of "nonsense syllables" could be found to create a test with the characteristics required. In the Minnan version of this experiment, therefore, we decided to create a series of novel compound words consisting of two elements, a nonlexical (i.e., meaningless or "nonsense") syllable (NS) followed by a lexical syllable (LS), such that the combination (NS + LS) was a novel construction in the language.

As shown in (11) below, 9 NSs were selected from the small inventory of possible but meaningless syllables in the language, together with 27 LSs having the requisite rime- and body-sharing properties desired. The result was an inventory of 27 distinct test items.

(11) Syllables used to create stimuli for Expt. 4

Non-lexical syllables (NS)	Lexical syllables (LS)
GA^{51}	LAM^{55} 'cage'
	LAN^{55} 'callus'
	LANG^{55} 'sparse'
SAI^{21}	KAM^{55} 'orange'
	KAN^{55} 'vicious'
	KANG^{55} 'male'
LA^{53}	TSAM^{55} 'hairpin'
	TSAN^{55} '[a surname]'
	TSANG^{55} 'palm leaf'
TSHUA^{55}	THAM^{13} 'phlegm'
	THAN^{13} 'to spring up'
	THANG^{13} 'worm'
TIA^{21}	GAM^{13} 'cancer'
	GAN^{13} 'face'
	GANG^{13} 'to be stunned'
KHA^{21}	HAM^{13} 'to hold in the mouth'
	HAN^{13} 'cold'
	HANG^{13} 'line'
THE^{55}	TAP^{3} 'to answer'
	TAT^{3} 'to arrive'
	TAK^{3} 'to fight against'

PHAI^{33} KHAP^3 'knocking the head
                                     on the ground (a ceremony)'
                                     KHAT^3 'to ladle'
                                     KHAK^3 'shell'
LIO^{53} SAP^3 'crumb'
                                     SAT^3 'to kill'
                                     SAK^3 'to push'

As an internal control on the frequencies of the LSs used in constructing these lists, the test items were selected in such a way that precisely the same 27 LSs could be used on the 9 rime-sharing lists as on the 9 body-sharing lists, simply by rearranging the specific test items appropriately. Thus, for example, the lexical syllable LAM^{55} 'cage' appears (with the same non-lexical syllable GA^{51}) both on one of the rime-sharing lists (namely, GA^{51}-LAM^{55}, GA^{51}-KAM^{55}, and GA^{51}-TSAM^{55}), as well as on one of the body-sharing lists (GA^{51}-LAM^{55}, GA^{51}-LAN^{55}, and GA^{51}- LANG^{55}); similarly, the lexical syllable KAM^{55} 'orange' appears on both lists, as well (albeit with different non-lexical syllables), as illustrated by the rime-sharing list GA^{51}-LAM^{55}, GA^{51}-KAM^{55}, and GA^{51}-TSAM^{55} and the body-sharing list SAI^{21}- KAM^{55}, SAI^{21}- KAN^{55}, and SAI^{21}- KANG^{55}. Consequently, even though the properties of interest were confined to the LS portions of the test items we used, precisely the same 27 LSs had to be recalled from both lists, neutralizing any possible frequency or phonetic weighting effects for the individual syllables involved (see Appendix 4 for the configuration of each of the two test lists).

For the purpose of the actual testing, pictures of nonsense creatures were drawn to match the test items that appear in the two lists shown in Appendix 4, each of which was assigned as a "name" for a distinct nonsense creature, whose picture was shown each time that test item was presented. These pictures were then grouped onto 18 cards (i.e., 9 for each of the rhyming sets and 9 others for the body-sharing sets), each containing three pictures whose names either rhymed or shared a common body element, and it was these names that the participants were asked to recall.

In order to distinguish readers from non-readers, a new multiple-choice reading test was constructed along the same general lines as the one used in the earlier English and Korean research. Since Minnan is not a written language, this test was constructed in Mandarin, which is the medium of instruction in all of the Chinese schools in Taiwan. Like its English and Korean counterparts, this was a 20-item picture test involving simple high frequency words (such as MAO^1 'cat', CHUAN^2 'ship', and MA^3 'horse'), with four systematically varied orthographic representations presented below each picture to choose from, only one of which was correct. Unlike the English and Korean versions,

however, the Mandarin reading test was presented in two forms, one for each of the orthographic systems that are used in Taiwan.

The first of these writing systems involves the traditional Chinese characters, which we had no reason to suspect would influence the results of the study in any particular way and which were included merely as a standard test of literacy. The main focus of the reading test, therefore, was on the Zhuyin Fuhao representations, since these were the ones likely to bias learners in the direction of an onset-rime analysis of syllables.

In any event, all readers and non-readers involved in the study now under discussion were assigned to these categories on the basis of their performance on both versions of the Mandarin reading test, using the same reading score (RS) criteria as in the earlier English and Korean studies: Non-readers were defined as participants who received an RS of 8 correct or less on each of both reading tests, while all readers we used in the main experiment had an RS of 14 or above on both tests.[9]

7.2.2 Methodology

Just as in the previous English and Korean versions, the children who participated in this study were shown the 18 picture cards described above, each of which displayed three nonsense animal pictures that were named by three of the compound test words listed in Appendix 4. The examiner pointed at the pictures one at a time, giving its name once and asking the child to repeat it aloud before moving on to the next picture. This naming and repeating ritual was then repeated two more times, giving each child a total of three opportunities both to hear and to say the name of each picture on the card. On the fourth presentation, however, only the pictures were indicated, and the child was required to recall the three names, in turn, on his or her own, and all three responses were transcribed by the examiner for later analysis and scoring, as well as recorded for later confirmation. (An occasional response was elicited twice, if the examiner found the child's first response to be unclear.) The examiner then presented the next picture card and the process was repeated until all 18 cards were completed. (Two three-picture practice cards, constructed on the same model of the test cards, were also used to begin each session, in order to give each child some familiarity with the nature of the task before the testing actually began. See appendix 4 for the two practice lists involved.)

Although, as already noted, each participant was thus asked to recall each lexical syllable twice over the course of the entire experiment (i.e., once for a test item on each of the two lists) the presentation order of the 18 sets of test items was randomized anew

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[9] See Yoon & Derwing (2001) for a statistical justification of the threshold values used, given the guessing factor of 25% that was operative in this task.

(by shuffling the cards) for each participant, in order to wash out any order or recall effects.

7.3 Results

The transcribed responses were scored by the same examiners who elicited them, and because all of the test items recalled were bisyllabic compound words, rather than the simple monosyllables of the earlier English and Korean studies, a few new complications did arise in the scoring. There was some controversy, for example, on the way a response should be scored if participants erred in their recall of the NS element but recalled the LS perfectly well. Under a completely strict scoring system, of course, any errors at all would be sufficient to label a response as incorrect. Some errors, however—such as errors involving the NS elements and even some mistakes involving the LSs, such as using the wrong tone—did not seem to bear on the crucial issue, which was whether the LS elements would be easier to recall if they all rhymed or if they shared a common CV-component instead. In the end, therefore, we developed a dual scoring system: a "strict" one in which any mistake in a response was sufficient to score it as an error, and also a "broad" one which ignored those mistakes that seemed to be irrelevant to the main research question of interest.

The results of this experiment are shown in (12) and (13) below, which show the correctness scores for both nonreaders (i.e., children with scores of 8 or less on both of the two 20-item reading tests) and readers (who all scored 14 or higher on both tests), using the "strict" and the "broad" scoring systems, respectively. In both tables, RS = score on reading tests, Tot Cor = total correct (maximum = 540), and M Cor = mean correct per participant (max = 27).

(12)　Group results of Minnan NWR experiments using the 'strict' scoring system

	Nonreaders (RS < 9)			Readers (RS > 13)	
	Ri	Bo		Ri	Bo
Tot Cor	54	103	Tot Cor	85	121
M Cor	2.7	5.2	M Cor	4.3	6.1
T-tests:	p < .001			p < .003	
	(Bo >Ri)			(Bo >Ri)	

(13)   Group results of Minnan NWR experiments using the 'broad' scoring system

	Nonreaders (RS < 9)			Readers (RS > 13)	
	Ri	Bo		Ri	Bo
Tot Cor	140	176	Tot Cor	193	226
M Cor	7.0	8.8	M Cor	9.7	11.3
T-tests:	p < .002			p < .009	
	(Bo >Ri)			(Bo >Ri)	

Although the readers, who were typically older, performed better overall on both the rime-sharing and body-sharing sets, it can be seen from the tables that the response pattern of both readers and nonreaders was the same on both sets, and the same was true whether the "strict" or the "broad" scoring system was used. In brief, the expected results emerged throughout, showing consistently better recall by all participant groups on at least the LS portions of the picture names when they appeared on the body-sharing lists (cards) than when the same LSs appeared on the rime-sharing lists. We take this as potential evidence that Minnan speakers do indeed treat the syllables of their language as a synthesis of distinct body and coda elements.

For all of this, since we raised questions about the first two experiments (even running a third experiment to help clarify the interpretation of the first), we should not let Experiment 4 get by without subjecting its results to some careful scrutiny, as well. Noting that knowledge of the Zhuyin Fuhao might have contaminated the results of Experiment 2, we avoided this possibility in the present experiment by testing a group of preliterate children, whose performance on a reading test indicated that they did not know even the basics of this writing system. Furthermore, by including precisely the same lexical syllables in both stimulus sets, we guaranteed that none of the individual onset-rime nor body-coda stimuli had any inherent advantages over the other, either from the standpoint of frequency considerations or from the standpoint of the kind of distributional or acoustic factors that may have contaminated the results of Experiment 1. However, since the stimuli in this last experiment were presented for recall in blocks of three, we cannot be absolutely certain that sets whose members all began with the highly salient onset consonants (i.e., the body-coda sets) might have had some inherent learnability advantage over sets that shared common low-saliency coda consonants instead, and until the role of such factors in recall is better understood, we can only be left to wonder.[10]

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[10] We did a similar (unpublished) NWR study with Mandarin that showed a preference for rime-sharing names, demonstrating that speakers of languages with simple syllable structures and unbalanced onset and coda inventories do not necessarily recall the names from body-sharing lists better. However, we

Moreover, to think back on our earlier critique of Experiment 2, which involved syllable-blending judgment preferences, we cannot ignore the important observation made in Wang (1996a) that it is may not be necessary to actually segment words and syllables in order to make judgments of the kind required in our Experiment 2, or even to perform some of the overt sub-syllabic manipulations that were involved in Wang's (1996a) study, which involved the insertion, deletion, and replacement of individual consonant and vowel segments.

Put another way, after nearly two decades of on-and-off experimental work on the internal structure of the Minnan syllable, and despite this latest effort, which seems to tilt the pendulum back in the direction of a body-coda analysis once again, we may actually be on ground that is not a whole lot firmer than it was at the start.

8. Concluding discussion: On the relative merits of external and internal evidence.

There is a long-standing (and somewhat pernicious) tradition in the field of linguistics to treat evidence in linguistics as representing one or the other of two fundamentally different categories. For linguists, at least, the oldest, most avidly sought, and most trusted and revered of these has come to be known as "internal" evidence, which is evidence based on the careful and detailed analysis of language forms, typically confined to the range from the speech sound up through the sentence (hence including such intermediate units as the syllable, the word, the phrase, the clause, etc.). Other types of evidence, such as evidence gathered through psycholinguistic experimentation (and even many types of naturalistic evidence, such as that acquired from such phenomena as slips of the tongue, spontaneous language games, and the like) are, sometimes quite disparagingly, assigned to the category of "external" evidence, which has tended to be viewed, at best, as the "poor sister" of the evidence family, useful sometimes (e.g., when the results "turn out right") to bolster formal descriptive accounts, perhaps, or, at worst, in some extreme accounts, to be regarded as so inherently variable and untrustworthy as to be dismissed as essentially useless.

By contrast, other linguists, such as ourselves, view "external" evidence in quite a different way, namely, as the chief safeguard we have to make sure that linguistic theory and description, in its preoccupation with the forms of language, does not end up postulating structural entities, processes, constraints, etc. that are valid *only* for the description of language forms, without saying anything of significance about the internal

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have no data about the relative saliency and Mandarin onsets and codas as yet, and Mandarin lacks stop codas altogether, so the language provides no clear acoustic parallels to the Minnan case.

representations and processes of the people who actually learn and use those forms, and who, in the final analysis, are the ones who actually created all of those forms in the first place. To us, therefore, psycholinguistic experimentation, for example, is not something that is an optional or convenient adjunct to the main business of the field (i.e., linguistic theory), but it is rather something that is absolutely essential to keep linguistic theorizing on the right track, as well as to introduce relevant new data and perspectives in its own right. Whether linguists like it or not, the fact remains that no theoretical linguistic claims to "psychological reality" can be empirically justified without support from the psychological domain to back them up.

In this perspective, the research described in the paper should be viewed as a series of attempts to determine, through a variety of experimental techniques, what kind of psychological reality is represented by the Minnan syllable for its speakers, and to ascertain whether the formal linguistics notions of onset-rime and body-coda have any real bearing on the language system that is internalized by contemporary speakers of the language. That we have been less than fully successful in our efforts, even after nearly two decades of trying, should come as no great surprise to the realists among us (though this result is, of course, more than a little disappointing to us as individual researchers). As we knew from the start, however, there is no magic involved in linguistic experimentation that leads the researcher inexorably to a correct solution to any theoretical problem, any more than there is any trustworthy source of revelation in linguistic theorizing itself. And just as much (and probably, in fact, the vast bulk) of linguistic theorizing will likely turn out in the end to be nothing more than speculative nonsense, experiments, too, can be faulty, invalid, even totally misleading in their own right. A good experiment is, in fact, no easier to come by than a good theory, and the test of both is the same: Do they withstand the tests of time and intensive scrutiny?

To be sure, the history of the experimental investigation of the internal structure of the Minnan syllable has been a long and tortuous one, with some experiments (such as Experiment 2 here, together with Wang, 1996b) seeming to point in the direction of a right-branching, onset-rime analysis like (1) above, while others (such as Experiments 1 and 4 here) pointing instead to a left-branching, body-coda analysis of the likes of (2). It has seemed that each new attempt has, in fact, deepened the mystery, rather than resolving it conclusively, as even our most recent and most carefully controlled study (Experiment 4) is not without a few rough edges. Under such circumstances it is tempting to conclude that the second author was correct in his suggestion made many some ago (in Wang, 1996a) that the syllables of this language are so simple in terms of their canonical

structure (with V, CV, VC, and CVC as the only possible types under some analyses[11]) and so limited in number (with only about 800 possible variations, ignoring tones) that they might be best viewed as unanalyzed wholes in the minds of their users, and subject to internal segmentation only under very artificial conditions that might arise out of formal education (as through the learning of one or more orthographic systems, or via training in a specific literary tradition) or from linguistic experience (such as exposure to other languages in which syllables have a different and perhaps more readily segmentable internal structure, and through experience with various types of language games, or even as the result of explicit training in connection with psycholinguistic experiments themselves), giving rise to a whole host of potential anomalies.

In the end, though, we always seem to come back to the nasal assimilation phenomenon in Minnan, as described in section 1 above, since the constraints involved would seem to require not only an analysis of the Minnan syllable into discrete subcomponents, but specifically into the kinds of units that are explicitly a part of a body-coda analysis, rather than some other type, as explicated below.

Consider a canonical syllable in Minnan of the form C1VC2, where C1 is the (optional) onset, V the vowel (or nucleus) and C2 the (optional) coda. Within such a framework, the full range of variation among nasalized and non-nasalized forms can be succinctly captured as the consequence of two explicit constraints:

First, a *nasal harmony constraint* specifies that, without exception, C1 and V must always agree in nasality (i.e., both segments must be either [+nasal] or [-nasal]), allowing for syllables like [ban] [bat], [ba], and [mã], but disallowing those like *[ma] and *[bã]. Note that in a body-coda analysis like (2), repeated below for ease of reference, all of the units needed for the formal description of this constraint in a straightforward way are automatically provided, since not only are C1 and V represented as units, but the two are joined together into a body unit at a higher level, which serves as a natural delineator of the scope of the constraint. (Within this framework, this constraint could thus be aptly characterized as something like "body-internal nasal harmony.") An analysis like (1), however, although it provides both the C1 (onset) and V (vowel) units, the first is a unit unto itself, while the second is the first part of the higher-order rime, raising serious questions about the scope of the phenomenon, such as "Why should the constraint extend across one natural boundary (between onset and rime), yet stop (after the vowel) where no natural intrasyllabic boundary exists at all?" (Similarly, an unanalyzed C1VC2 syllable raises the question as to why the constraint operates only two-thirds of the way through, by incorporating C1 but excluding C2, in a seemingly quite arbitrary manner.)

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[11] If the glides /y/ and /w/ are analyzed separately from the vowels, these can also occur in both pre- and post-vocalic position, unless another consonant follows (i.e., the patterns *CVGC and *CGVGC are not permitted).

(1)   Syllable

Onset   Rime

C1   V   C2

(2)   Syllable

Body   Coda

C1   V   C2
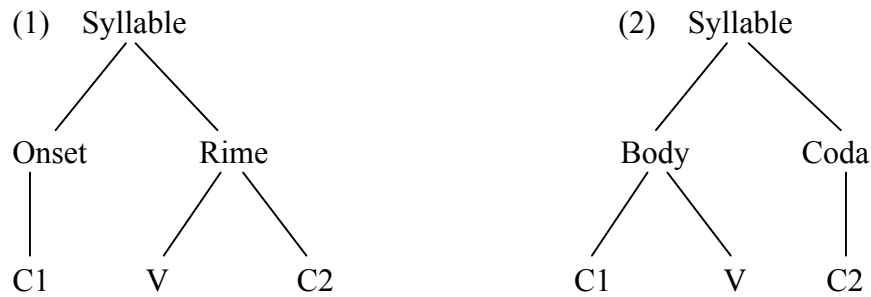
Second, a *nasal blocking constraint* operates between the V and C2, such that if the former is [+nasal], the latter must be [-nasal]). While this might be construed as a constraint operating between the two components of the rime unit in an analysis like (1), its "blockage" character seems unmotivated, since there is no syllable-internal boundary involved (which would also be the case in an unanalyzable whole syllable approach, as well, of course). Within a body-coda analysis like (2), however, the "blockage point" seems quite natural, as the constraint can be seen as one that is operative between the higher-order body and the coda units themselves. In short, nasality within the body (as described in (8a) above) is blocked at the body-coda boundary, thus accounting for the impossibility of a syllable like *[mãn].[12]

Given the myriad factors that have repeatedly plagued the interpretation of psycholinguistic experimentation on this problem from the start—and as difficult as it may be for committed experimentalists such as ourselves to admit—this purely formal, descriptive account may well provide (at the present time, at least) the best evidence we have in support of the conclusion not only that the Minnan syllable is analyzed at all, but that the subcomponents involved are precisely those that appear in the body-coda analysis of (2). It is important to recognize, however, that even such "best" evidence is still not good enough, when the question is formulated in terms of whether or not that the structures involved have psychological reality for contemporary speakers of the language.

To highlight this point, we may consider the following alternative interpretation: Suppose, for example, that something like the structure of (2) above were present in the language only at some earlier historical stage, rather than as part of the internalized apparatus that contemporary speakers know and use. This would provide a framework within which a nasality pattern of the kind described above might quite naturally have arisen. As the language passed from one generation to another, however, the syllable

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[12]   James Myers points out that there is also a constraint on the occurrence of labials (including labialized or rounded vowels) that also depends on the presence of a natural boundary between the C1V and C2 portions of a Minnan syllable. Specifically, labials can occur on either side of this demarcation line, but not on both simultaneously. (Thus /pun/ and /tim/ are allowed, but */pim/ and */tum/ are not.) We note, however, that some rare exceptions do occur, such as the Minnan word for 'ginseng', which is /som/, at least in some dialects.

types involved might well carry on, without necessarily passing along either the original motivating structures or even the constraints, so long as the number and diversity of available syllable types overall were small enough to allow for their learning, storage and recall as unanalyzed wholes (a situation that we have already noted is quite feasibly the case for the syllable inventory of contemporary Minnan).[13]

Parallel cases of phenomena of this kind are legion in the history of language, whereby a phonological phenomenon is born under one set of structural conditions, only to die off when those conditions change or vanish, leaving its mark in the form of a synchronically anomalous set of historical artifacts. To take just one simple example as a case in point, consider the irregular stem alternations between /f/ and /v/ in some English plural forms. This distinction originated in Old English, when a phonological constraint limited intervocalic fricatives to voiced variants (e.g., [v]) in an intervocalic environment, thereby yielding such pairs as *leaf-leaves, loaf-loaves, thief-thieves, wife* [OE /wi:f/]-*wives*, etc., when the plural suffix –es (which at the time contained a vowel, as the spelling suggests) was added to stems ending in /f/. By AD 1400 or so, however, the constraint had vanished (along with the suffix vowel), leaving the anomalous plural forms in stem-final /v/ in the modern language, which, being no longer motivated by either phonological constraints or underlying representations, must therefore be learned by rote as irregular forms by contemporary speakers.[14] (Note that no general rule or constraint is involved in modern English, as evidenced by such singular-plural pairs as *chief-chiefs, oaf-oafs, fief-fiefs*, etc., in which the final /f/ of the stem remains before the regular /-s/ variant of the plural suffix.)

To conclude this discussion, it is perhaps also worthwhile to note that there is actually no hard evidence at all to indicate that syllable structures are best represented as hierarchical tree diagrams, as illustrated in (1) and (2) in the opening paragraph of this paper. If anything, in fact, what evidence we do have would rather suggest that something akin to a syllable-internal "glue" or magnet-like attraction is more likely to be involved, yielding boundaries and break-points that are more fuzzy than sharp, and more malleable than hard and fast. (See, for example, Derwing & Nearey, 1991, on the "vowel-stickiness" phenomenon, for further discussion.)

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[13] It is quite possible, of course, to turn this argument around (as many descriptive linguists most probably would) and argue that the internal evidence described above is precisely the kind that would likely incline a child learner of this language—who is, after all, exposed only to language forms and their contexts, not to any underlying structures per se—to opt for an underlying structure like (2), as opposed to either one like (1) or to one that regarded all syllables as unanalyzed wholes. Though not at all unreasonable, such a step also requires some clear supporting evidence in order to be accepted, and not only is such evidence still lacking in the Minnan case, the fact is that we currently know practically nothing about the factors that actually motivate children to choose one internalized structure rather than another.

[14] Thanks to Tom Priestly for suggesting this example and for providing some of the details.

In the final analysis, therefore, despite all our best efforts over two decades to find the "correct" (i.e., psychologically real) account of the internal structure of the Minnan syllable, none of the studies cited present a thoroughly convincing account, not even the latest one presented at Experiment 4 in this paper. In the end, there is still no clear and unassailable evidence that the Minnan syllable is naturally segmentable at all, and much remains to be said for the whole syllable account of Wang (1996a). Thus the most that we can add to that here is to say that, if the Minnan syllable is indeed segmentable, then the body-coda analysis of (2) would seem, on the basis of all the evidence currently available, to be the one most likely to be on the right track.

To be sure, this may be a rather wishy-washy position to have to take, after having devoted so much time and effort to a resolution of the problem, raising the question of whether we have really learned anything worth learning from all our efforts. Thankfully, the answer to that question is positive, for we can at least articulate the following advances in knowledge with considerable confidence:

(1) We now know with little doubt that the distributional and/or acoustic patterns of segments within a syllable can contribute to perceived differences in salience between some parts of a syllable (such as onset consonants) and another (such as coda consonants), as documented in section 5.3 above, and this knowledge can now contribute to the design of better experimental vehicles in this area in the future;

(2) We also know with much certainty that knowledge of an orthographic system can not only strongly influence phonological awareness (and thus affect the results psycholinguistic experiments that involve the making of overt judgments)—a finding that goes back at least as far as the work of Ehri and Wilce (1980) on English—but that such biases can also be transferred in multilingual speakers from one of their languages to another, as documented in the discussion of section 6 above on the interaction of Mandarin and Minnan, and this knowledge is certain to have quite profound effects on future work of this kind with written languages of all types;

(3) Finally, and perhaps most importantly, we now also know that experimental techniques that may yield valid and consistent results with some languages (such as sound similarity judgments and word-blending in assessing syllable-internal structure in English) may not do so with some other languages (such as Minnan, as shown in Experiments 1 and 2 above), because of important differences in the linguistic and non-linguistic conditions involved. This means that we cannot simply build up a stock of "useful techniques" that can be thrown willy-nilly at each new language that comes up, but we must choose our methods more circumspectly, taking into account the kinds of factors that past experience has shown us might lead to misleading results.

In short, while each new experiment contributes something (if nothing more than the belated recognition of its own faults) to our knowledge base in any field, the quest for

empirical truth seems to be not only incremental, slow (sometimes painfully so!) and cumulative (with only rare Kuhnian-type theoretical breakthroughs), but also never-ending, yet the search is no less intriguing for all of that, and there is much satisfaction to be gained from even the smallest steps, when these result in new contributions to knowledge that are real and lasting.

Acknowledgements

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Appendix 1: Stimuli for Experiment 1

A. Test items (repetitions removed)

1a. kim^{55} : $king^{55}/tsim^{55}$ 2a. hin^{13} : $hing^{13}/tin^{13}$
1b. $tsin^{55}$: $tsing^{55}/sin^{55}$ 2b. $ting^{13}$: $tim^{13}/khing^{13}$
1c. kam^{55} : kan^{55}/sam^{55} 2c. han^{13} : $hang^{13}/tan^{13}$
1d. $tsan^{55}$: $tsang^{55}/than^{55}$ 2d. $tang^{13}$: $tam^{13}/lang^{13}$

3a. $tsing^{51}$: $tsim^{51}/king^{51}$ 4a. $tsim^{21}$: $tsing^{21}/sim^{21}$
3b. bin^{51} : $bing^{51}/phin^{51}$ 4b. sin^{21} : $sing^{21}/tin^{21}$
3c. $tang^{51}$: $tan^{51}/phang^{51}$ 4c. $tsam^{21}$: $tsan^{21}/kham^{21}$
3d. ban^{51} : $bang^{51}/san^{51}$ 4d. san^{21} : $sang^{21}/than^{21}$

5a. tin^{33} : $ting^{33}/kin^{33}$ 6a. sap^{2} : lap^{2}/sak^{2}
5b. $bing^{33}$: $bin^{33}/sing^{33}$ 6b. tak^{2} : $khak^{2}/tat^{2}$
5c. tan^{33} : $tang^{33}/pan^{33}$ 6c. sip^{2} hip^{2}/sik^{2}
5d. $bang^{33}$: $ban^{33}/lang^{33}$ 6d. tik^{2} : sik^{2}/tit^{2}

7a. bit^{3} : bik^{3}/zit^{3} 7c. bat^{3} : bak^{3}/tat^{3}
7b. $tsik^{3}$: $tsit^{3}/sik^{3}$ 7d. $tsak^{3}$: $tsat^{3}/hak^{3}$

B. Control items

1e. kim^{55} : $kim^{55}/tsim^{55}$ 4f. $tsam^{21}$: $kam^{21}/tsong^{21}$
1f. $tsan^{55}$: $tsong^{55}/kan^{55}$ 5e. tan^{33} : tim^{33}/pan^{33}
2e. hin^{13} : him^{13}/hin^{13} 5f. $bing^{33}$: $sing^{33}/bing^{33}$
2f. $tang^{13}$: $bang^{13}/tun^{13}$ 6e. tak^{2} : $tak^{2}/thit^{2}$
3e. bin^{51} : $bin^{51}/bing^{51}$ 6f. sip^{2} : sit^{2}/sok^{2}
3f. $tang^{51}$: zim^{51}/tan^{51} 7e. bit^{3} : but^{3}/zit^{3}
4e. sin^{21} : $sing^{21}/sin^{21}$ 7f. $tsak^{3}$: $hak^{3}/tsip^{3}$

Appendix 2: Stimuli for Experiment 2

A. Test items

1a. san^{55} + $tsim^{55}$ → sim^{55}/sam^{55}
1b. $tsim^{55}$ + san^{55} → $tsin^{55}$/$tsan^{55}$
1c. san^{55} + $tsim^{55}$ → sam^{55}/sim^{55}
1d. $tsim^{55}$ + san^{55} → $tsan^{55}$/$tsin^{55}$

2a. $hang^{13}$ + tin^{13} → hin^{13}/han^{13}
2b. tin^{13} + $hang^{13}$ → $ting^{13}$/$tang^{13}$
2c. $hang^{13}$ + tin^{13} → han^{13}/hin^{13}
2d. tin^{13} + $hang^{13}$ → $tang^{13}$/$ting^{13}$

3a. tan^{51} + $ping^{51}$ → $ting^{51}$/$tang^{51}$
3b. $ping^{51}$ + tan^{51} → pin^{51}/pan^{51}
3c. tan^{51} + $ping^{51}$ → $tang^{51}$/$ting^{51}$
3d. $ping^{51}$ + tan^{51} → pan^{51}/pin^{51}

4a. $tsan^{21}$ + sim^{21} → $tsim^{21}$/$tsam^{21}$
4b. sim^{21} + $tsan^{21}$ → sin^{21}/san^{21}
4c. $tsan^{21}$ + sim^{21} → $tsam^{21}$/$tsim^{21}$
4d. sim^{21} + $tsan^{21}$ → san^{21}/sin^{21}

5a. $tang^{33}$ + bin^{33} → tin^{33}/tan^{33}
5b. bin^{33} + $tang^{33}$ → $bing^{33}$/$bang^{33}$
5c. $tang^{33}$ + bin^{33} → tan^{33}/tin^{33}
5d. bin^{33} + $tang^{33}$ → $bang^{33}$/$bing^{33}$

6a. sik^{2} + tap^{2} → sap^{2}/sip^{2}
6b. tap^{2} + sik^{2} → tak^{2}/tik^{2}
6c. sik^{2} + tap^{2} → sip^{2}/sap^{2}
6d. tap^{2} + sik^{2} → tik^{2}/tak^{2}

7a. bak^{3} + $tsit^{3}$ → bit^{3}/bat^{3}
7b. $tsit^{3}$ + bak^{3} → $tsik^{3}$/$tsak^{3}$
7c. bak^{3} + $tsit^{3}$ → bat^{3}/bit^{3}
7d. $tsit^{3}$ + bak^{3} → $tsak^{3}$/$tsik^{3}$

B. Control items

1e. san^{55} + $tsim^{55}$ → $sang^{55}$/sim^{55}
1f. $tsim^{55}$ + san^{55} → $tsin^{55}$/$tsong^{55}$
2e. $hang^{13}$ + tin^{13} → $hang^{13}$/han^{13}
2f. tin^{13} + $hang^{13}$ → $tang^{13}$/tin^{13}
3e. tan^{51} + $ping^{51}$ → tan^{51}/$ting^{51}$
3f. $ping^{51}$ + tan^{51} → pin^{51}/$ping^{51}$
4e. $tsan^{21}$ + sim^{21} → $tsong^{21}$/$tsam^{21}$
4f. sim^{21} + $tsan^{21}$ → san^{21}/$sing^{21}$
5e. $tang^{33}$ + bin^{33} → $tang^{33}$/tin^{33}
5f. bin^{33} + $tang^{33}$ → $bing^{33}$/bin^{33}
6e. sik^{2} + tap^{2} → sik^{2}/sip^{2}
6f. tap^{2} + sik^{2} → tik^{2}/tap^{2}
7e. bak^{3} + $tsit^{3}$ → bak^{3}/bit^{3}
7f. $tsit^{3}$ + bak^{3} → $tsik^{3}$/$tsit^{3}$

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Appendix 3: Stimuli for Experiment 3

A. Test items

1. C_1VC-C_2VC
    tan^{55}-kan^{55}
    kan^{13}-tan^{13}
    bin^{33}-$tsin^{33}$
    $tsin^{51}$-bin^{51}

2. CV_1C-CV_2C
    tin^{55}-tan^{55}
    tan^{13}-tin^{13}
    $tsun^{33}$-$tsin^{33}$
    $tsin^{51}$-$tsun^{51}$

3. CVC_1-CVC_2
    tam^{55}-tan^{55}
    tan^{51}-tam^{51}
    $tsin^{33}$-$tsit^{3}$
    $tsit^{2}$- $tsin^{21}$

4. C_1V_1C-C_2V_2C
    tan^{55}-kin^{55}
    kin^{51}-tan^{51}
    $tsin^{33}$-bun^{33}
    bun^{21}-$tsin^{21}$

5. CV_1C_1-CV_2C_2
    tan^{55}-tim^{55}
    tim^{13}-tan^{13}
    $tsin^{33}$-$tsut^{3}$
    $tsut^{2}$-$tsin^{21}$

6. C_1VC_1-C_2VC_2
    kam^{55}-tan^{55}
    tan^{51}-kam^{51}
    bit^{3}-$tsin^{33}$
    $tsin^{21}$-bit^{2}

7. Initial and final contrasts

    lan^{13}-ban^{13}
    gan^{13}-lan^{13}
    ban^{51}-lan^{51}
    lan^{51}-gan^{51}

    lan^{13}-lam^{13}
    $lang^{13}$-lan^{13}
    lam^{51}-lan^{51}
    lan^{51}-$lang^{51}$

B. Control items

8. $C_1V_1C_1$-$C_1V_1C_1$
    tan^{55}-tan^{55}
    cin^{33}-cin^{33}
    $pang^{51}$-$pang^{51}$
    $tsit^{2}$- $tsit^{2}$

9. C1V1C1-C2V2C2
    kim^{55}-tan^{55}
    tan^{51}-kim^{51}
    bak^{3}-cin^{33}
    $tsin^{21}$-bak^{2}

10. Tone contrasts
    tan^{55}-tan^{33}
    kam^{21}-kam^{55}
    $chim^{55}$-$chim^{51}$
    pe^{13}-pe^{55}
    sim^{33}-sim^{21}
    $bong^{51}$-$bong^{33}$

11. Tone + segment contrasts
    kim^{33}-tan^{55}
    sun^{55}-kam^{21}
    $kong^{51}$-$chim^{55}$
    tsi^{55}-pe^{13}
    $khun^{21}$-sim^{33}
    lun^{33}-$bong^{51}$

giam^{33}-giam^{13} pu^{13}-giam^{33}
tsien^{21}-tsien^{51} giu^{51}-tsien^{21}
tai^{13}-tai^{21} sang^{21}-tai^{13}
tsua^{51}-tsua^{13} gu^{13}-tsua^{51}
lap^{3}-lap^{2} hok^{2}-lap^{3}

Appendix 4: Stimuli for Experiment 4

A. Practice lists

   1. ki^{33}-lim^{51} ki^{33}-tsim^{51} ki^{33}-gim^{51}

   2. ki^{33}-lim^{51} ki^{33}-lin^{51} ki^{33}-ling^{51}

B. Rime-sharing test lists

1.	ga^{51}-lam^{55}	ga^{51}-kam^{55}	ga^{51}-tsam^{55}
2.	sai^{21}-lan^{55}	sai^{21}-kan^{55}	sai^{21}-tsan^{55}
3.	la^{51}-lang^{55}	la^{51}-kang^{55}	la^{51}-tsang^{55}
4.	tshua^{55}-tham^{13}	tshua^{55}-gam^{13}	tshua^{55}-ham^{13}
5.	tia^{21}-than^{13}	tia^{21}-gan^{13}	tia^{21}-han^{13}
6.	kha^{21}-thang^{13}	kha^{21}-gang^{13}	kha^{21}-hang^{13}
7.	the^{55}-tap^{3}	the^{55}-khap^{3}	the^{55}-sap^{3}
8.	phai^{33}-tat^{3}	phai^{33}-khat^{3}	phai^{33}-sat^{3}
9.	lio^{51}-tak^{3}	lio^{51}-khak^{3}	lio^{51}-sak^{3}

C. Body-sharing test lists

1.	ga^{51}-lam^{55}	ga^{51}-lan^{55}	ga^{51}-lang^{55}
2.	sai^{21}-kam^{55}	sai^{21}-kan^{55}	sai^{21}-kang^{55}
3.	la^{51}-tsam^{55}	la^{51}-tsan^{55}	la^{51}-tsang^{55}
4.	tshua^{55}-tham^{13}	tshua^{55}-than^{13}	tshua^{55}-thang^{13}
5.	tia^{21}-gam^{13}	tia^{21}-gan^{13}	tia^{21}-gang^{13}
6.	kha^{21}-ham^{13}	kha^{21}-han^{13}	kha^{21}-hang^{13}
7.	the^{55}-tap^{3}	the^{55}-tat^{3}	the^{55}-tak^{3}
8.	phai^{33}-khap^{3}	phai^{33}-khat^{3}	phai^{33}-khak^{3}
9.	lio^{51}-sap^{3}	lio^{51}-sat^{3}	lio^{51}-sak^{3}

閩南語音節：矛盾證據的合理化

Bruce L. Derwing[a]　　王旭 [b]　　蔡素娟 [c]

亞伯他大學 [a]

元智大學 [b]

國立中正大學 [c]

　　傳統觀念認為漢語音節結構是右分枝（聲韻），但最近一些證據顯示閩南語的音節結構可能是左分枝（體尾）。本文整理閩南語左分枝結構的證據，檢討四個心理實驗的結果，然而前兩個實驗的結果互相矛盾，而後兩個的結果也還是無法解決這個問題。本文詳細討論這些問題困難點的原因，做了一個暫時的結論，認為我們可能沒有很強的理由一定要把閩南語音節視為有內部結構的。閩南語音節可能只是一個不再細部分析的整體。

關鍵詞：閩南語、音節結構、實驗、聲韻結構、體尾結構、整體