

CONCEPT FORMATION AS A TOOL FOR THE INVESTIGATION OF PHONOLOGICAL UNITS IN TAIWANESE

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ABSTRACT

Using a concept formation task, 140 subjects were exposed to one of eight different target sets of real Taiwanese words, with each target defined in terms of a different subcomponent of a CVC syllable. Results showed that the onset targets were easier to learn than the coda targets, while the rime and body targets were about equally difficult. The general difficulty of all tasks, however, suggested that none of the words were readily analyzed into subcomponents.

THEORETICAL BACKGROUND

Since the invention of the International Phonetic Alphabet over a century ago, western linguists have tacitly assumed that the speech streams of all languages were naturally analyzable into segment- or phoneme-sized units, i.e., into individual consonant (C) and vowel (V) elements. Thus westerners have traditionally treated syllables like /na/ to be segmented into a C plus a V unit (i.e., as CV) and /tun/ into CVC, with both of examples sharing a common /n/ element in this case. Although this is a seemingly obvious conclusion to be drawn by speakers of languages that use a segment-based alphabet, such as the Latin or the Greek, the universality of this assumption may not be valid. The Chinese languages pose a particularly interesting case for testing this assumption, in that the syllable patterns they exhibit are relatively simple (often with CVC as the most complicated case), with the result that none of these languages involve more than about 1000 distinct syllable types, a number that could in principle be readily perceived and stored by speakers as unanalyzed wholes.

Though experimental psycholinguistic research in the Chinese languages is lamentably rare, one recent study has provided some hard evidence in favor of the non-segmentation or "whole syllable" hypothesis for these languages. Specifically, in an experiment performed

on the Chinese Mainland, Read et al. [1] demonstrated that some native speakers of Mandarin had great difficulty in performing a seemingly simple substitution task, namely, to replace one initial consonant in a Chinese word or syllable by another consonant (e.g., to change a word like /san/ into /nan/). Interestingly, the speakers who had this difficulty were all older ones, who, though literate in the use of Chinese characters, had not been exposed in school to the Latin-based *pinyin* transliteration scheme, which is, of course, segment-based. The authors concluded from this that the segment may not be a natural phonological unit for Chinese, but only one that is learned through exposure to a writing system that represents each segment as a distinct orthographic unit.

The present study is an attempt to extend this line of research to another language in the Chinese family and to a wider range of potential syllable subcomponents. Taiwanese was chosen as the specific vehicle for this extension both because of its structural properties (specifically, because it exhibits a wider range of coda consonants than is typical of the family) and especially because no segment-based writing system is directly associated with it in the Taiwanese educational system.¹

THE CONCEPT FORMATION TASK

The particular experimental task that we have selected for this investigation is the so-called "concept formation" technique. This is a widely used technique in experimental psychology, where it has been applied to test subjects' categorization ability with a variety of complex stimuli [2,3,4]. It has also been fairly widely used to test a variety of linguistic concepts, including word meanings [5], sentence types [6], phonemes [7], phonetic features [8] and even vowel alternation sets linked to hypothesized morphophonemic rules [9]; see [10] for an overview.

The particular version of the CF technique that is employed here is called the *identification* method [2], in which subjects are exposed to one stimulus at a time. In this task, subjects are trained to recognize a target set defined on some structural property of interest (e.g., words containing the onset /l/, which would include words like /ta51/, /tun24/, /tap33/, etc. but exclude words like /pa51/, /kun24/, /ap11/, etc.²). As the training proceeds, the subjects' best guesses as to the defining property are reinforced through feedback to responses of either "Yes" (used when a subject thinks that a particular test item is included in the set) and "No" (when he/she thinks that a particular test item is *not* included). Success in mastering a target can be measured in terms of the number of subjects who satisfy some fixed response criterion (e.g., ten consecutive correct responses), the average number of trials to reach this criterion and/or by the total number of correct responses on the test.

The main assumption that lies behind the use of this technique is that a target set will be more readily mastered if its defining property is already available to subjects (i.e., if they readily recognize it as a salient property on the basis of their prior experience) than if it is not (which means that the subject would presumably have to work it out for the first time during the course of the experiment itself). Thus for a language in which C₁VC₂ syllables were naturally broken into onset (C₁) plus rime (VC₂) subcomponents, targets defined in terms of these elements ought to be more readily identified than targets defined in terms of an arbitrary body (C₁V) vs. coda (C₂) subdivision.

TAIWANESE PHONOLOGICAL UNITS AS TARGET CATEGORIES

Our study focussed on the following eight different potential subdivisions of the Taiwanese C₁VC₂ syllable:

- (1) the onset, C₁ (e.g., words beginning in /t-/);
- (2) the coda, C₂ (e.g., words ending in /-n/);
- (3) the nucleus V, with a fixed falling tone (e.g., words containing /a51/);

- (4) the nucleus V, with varied tones (e.g., words containing any /a/ vowel, regardless of tone);
- (5) tone alone (e.g., words containing a falling 51 tone, regardless of the vowel or either of the consonants, i.e., V51);
- (6) the rime, VC₂ (e.g., words containing both the vowel with varied tones of (4) and the coda of (2), i.e., /-an/);
- (7) the body, C₁V (e.g., words containing both the onset of (1) and the vowel with varied tones of (4), i.e., /ta-/); and
- (8) the margins C₁...C₂ (e.g., words containing both the onset of (1) and the coda of (2), regardless of the vowel or the tone, i.e., /t-...-n/).

Since attention was focussed on potentially competing elements at both the monosegmental (onset vs. coda vs. nucleus) and bisegmental (rime vs. body vs. margins) levels, distractor sets within each level were carefully selected to maintain a balance in terms of number and range of variation from targets, and the reinforcement schedule was exactly the same across all eight target categories. The final stimulus set consisted of 100 words for each target category, half of them conforming to the defining characteristics of the target and the other half not (distractors).³ After the master lists were organized to maximize parallelisms across target categories, the stimuli were then placed in a fixed, random order for recording and presentation to subjects.

SUBJECTS AND PROCEDURE

Subjects were 160 army recruits stationed at a military base near Hsinchu, Taiwan. Soldiers were chosen as subjects because of their representativeness in terms of educational background, and also because of their relatively limited exposure to English, especially in comparison with university students. Twenty of these soldiers were randomly assigned to each of the eight target categories. All subjects were male and each was paid NT\$100 for his participation in the experiment.

Before the administration of the main experiment, subjects were given two short pretests, one to assess their ability to discriminate a sample of the stimuli and a second to illustrate the CF experimental procedure. This latter practice session consisted of 50 Taiwanese com-

pound words, 24 of which were targets defined in terms of the syllable /ki33/ as the first element of the compound. (Performance on the practice test showed an understanding of the task and varied only slightly across the subject groups. There were no discrimination problems.)

In both the practice session and the main experiment, stimuli were recorded on individual tapes for presentation in the language laboratory at the National Tsing Hua University. Each stimulus was presented twice, with a pause of 4 seconds to allow the subject to record his "Yes" or "No" response before the correct answer was provided. Subjects were tested together in groups of 40.

RESULTS AND CONCLUSIONS

Responses were recorded as 2 ("Yes"), 1 ("No") and 0 ("no response"). Because of a large number of "no response" answers (over 30% of the total), 20 subjects were eliminated from the analysis; for the remaining 140 subjects the "no response" rate averaged a respectable 2.8%. For each of these 140 subjects, a "percent correct" (%C) figure was calculated, based on total number of matched responses to the key (i.e., all mismatched and null responses were tabulated as errors).

Since less than 20% of the subjects managed to supply ten consecutive correct responses, this criterion for mastery was abandoned as too rigid under the time constraints that were imposed on responses in this particular experiment. For the purpose of making trials to criterion calculations, therefore, the criterion was set at 12 correct out of 14 consecutive responses, which does not require a long string of error-free performance but is still very difficult to achieve by chance ($p = .0065$ for a binomial distribution). For subjects who satisfied this criterion, the number of trials to reach it was tabulated directly; for the remaining subjects, a figure of 101 was arbitrarily assigned for purposes of the analysis (i.e., one more trial than the total number of stimuli provided on the test).

Table 1 below shows the number of subjects in each target group, the subset of these who reached criterion (#S), the average number of trials required to reach it (#T) and the overall mean

Table 1. Total number of subjects number of subjects reaching criterion, average trials to criterion and overall percent correct responses for each target category.

Target	N	#S	#T	%C
(1) Onset	18	7	80.4	56.9
(2) Coda	17	1	96.3	49.6
(3) /a51/	16	8	78.8	57.6
(4) /a/	20	2	96.7	55.1
(5) /V51/	19	4	86.7	53.9
(6) Rime	16	7	80.0	56.6
(7) Body	17	8	74.5	58.5
(8) Mar	17	4	88.3	51.9

percent correct (%C) for each of the eight target categories. These results indicate that the coda category (2) was more difficult to identify than either the onset (1) or the toned nucleus (3), by all three measures: far fewer subjects reached criterion (1 vs. 7 and 8), the average trials to criterion was higher (over 96 vs. about 80 for the other two), and the overall percent correct was significantly lower (49.6 vs. 56.9 and 57.6; $p < .05$). There was no significant difference in percent correct between the rime and the body, nor, in fact, between any of the other %C means that did not involve the coda. (This special status of the coda is consistent with our earlier finding [11], based on global sound similarity judgments, that the coda is the least salient component of a Taiwanese syllable.) The #S and #T figures also show a big difference between the /a51/ and /a/ targets, suggesting a problem in separating a vowel from its tone (cf. [12]); this difficulty is not reflected by a significant difference in the %C results, however.

Perhaps the most outstanding feature of the results summarized in Table 1, though, is that performance on all eight of the tasks was relatively poor. Even in the quantitatively best case (Body), fewer than half of the subjects (8/17) reached criterion over the course of 100 trials, with an average value of about 75 trials. (Ignoring the subjects who did not reach criterion, the average trials for those eight subjects who did was still a rather unimpressive 44.6.) Moreover, even in this best case, the average percent correct was less than 59% (with 50% to be expected by chance for overt responses).

In sum, therefore, we conclude on the basis of the present data, at least, that while Taiwanese syllables can be subdivided into smaller units by some subjects, in response to task demands of the kind that were imposed by this experiment, most subjects find this to be a very difficult and unnatural thing to do. For most purposes, therefore, we see the syllable as the smallest viable phonological unit in Taiwanese, and probably in Chinese generally. At least this is true for speakers who have not been trained in *pinyin* or any other segment-based alphabetic scheme.

NOTES

¹Although elementary school children in Taiwan are exposed to an onset-rime based transliteration scheme for Chinese called *chuyinfuhao*, this system is used only for the teaching of Mandarin in the early grades and is never used for Taiwanese. The same is true of the Latin alphabet, which is only used in basic English classes.

²The numbers in these and other examples represent tones.

³Since all target words had to be repeated at least once in order to achieve 50 items, 10 distractors were also repeated to discourage the strategy of focussing on repeated words.

⁴Overall, the mean #T figure is 51.3 trials for the 25 out of 140 subjects who satisfied the more rigid criterion of ten consecutive correct responses; this compares to an average of 38 trials in an earlier study [9], where 25 out of 35 high school students satisfied the same criterion on the quite abstract task of categorizing a variety of English vowel alternation sets.

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