

## **A Concept Formation Experiment on the Nasality of Vowels in Taiwan Min\***

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In Wang 1996 we performed an experiment to test if the subjects treated the oral voiced stops and their corresponding nasal stops as the same phonemes. We found that the [b, m] pair and the [g, ŋ] pair were unambiguously accepted, while the [l, n] pair was equivocal, and tended to be regarded as different phonemes. We concluded from the results that the theoretical predictions were generally correct, but the /l/ phoneme was on the way to be split in two. In this present study we pursued the corollary question: whether the oral and nasal vowels were considered different. Four groups of subjects were recruited, with each group involving in one of four test conditions. In each test condition, the subjects were required to respond positively to the oral vowel [i], [e], [a] or [ɔ] respectively, and negatively to other vowels. In the test session, the subjects were tested on how they respond to the nasal counterpart of the target vowel in the learning session, i.e., [ĩ], [ẽ], [ã] or [õ] respectively. The results showed that the test vowels received much more 'yes' answers than 'no' answers, meaning that they considered the nasal vowels to belong to the same category as the oral vowels. In other words, nasality is not important in vowels either. Therefore, we conclude that the segmental theory of the nasal phonemes in Taiwan Min is not supported by the results of this experiment. We propose an autosegmental theory in its stead, as outlined in Wang 1995. The validity of such a claim, however, is a subject for further experimental research.

Key words: Taiwan, Min, nasality, concept formation, experimental phonology

### **1. Nasal vowels in Taiwan Min**

Taiwan Min has been known to distinguish between nasal and oral vowels. Thus, [ti55] 'pig' and [fi55] 'sweet' are distinguished phonetically only by the fact that the former word has an oral vowel while the latter has a nasal vowel. It is also observed that the nasality of the voiced consonants preceding the vowels has to agree with that of the

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vowel in the syllable. For example, [bi33] ‘smell’ and [mi33] ‘noodles’ are good forms while \*[mi33] and \*[bi33] are not.

Traditionally, linguists have considered nasality to reside in the vowel (T. H. Tung 1957) because there are syllables such as [i33] ‘yard’ where the nasality cannot be derived from a consonant. In generative terms, nasality in vowels is underlying, while that in consonants is derived by assimilation. Thus, in this theory, the difference between [b] and [m] is considered allophonic, while that between [i] and [ĩ] is phonemic.

In Wang 1996, we performed an experiment to test whether nasality in the voiced consonants is considered insignificant by native speakers. Three groups of subjects were recruited in a concept formation test where each group worked on one particular concept: [b-m], [l-n] or [g-ŋ]. Subjects in each group were first taught to respond positively to the oral voiced stop consonant [b], [l] or [g], and negatively to other consonants. In the test session, the subjects were observed on how they responded to the nasal consonants: whether they would regard [m] to be in the same category with [b], [l] with [n] and [g] with [ŋ]. The results showed that the subjects did not consider [b, m] and [g, ŋ] to be separate phonemes, although they were undecided about the difference between [l] and [n]. We concluded that the view that nasality in initial consonants is not significant was supported (see also Pan 1996).

In this study, we are interested in finding out whether nasality is significant for vowels. As a corollary to the theory that nasality in initial consonants is not significant, it is natural to expect nasality to be underlying in vowels, if the traditional assumption (represented by Tung 1957) is correct. Thus a concept formation experiment was designed in which the subjects were asked to respond to oral vowels in a syllable, and decide in the test session whether they thought nasal vowels were distinguishable from oral vowels.

Concept formation is an experimental paradigm which is quite often employed in psychological studies. This paradigm assumes that the subjects will respond readily to concepts which they are already aware of, and poorly to those which they do not have. In this type of experiment, the subjects are asked to respond positively to tokens containing the target concept and negatively to others. After the subjects make the response, they are usually reinforced with ‘yes’ or ‘no’ such that they can check their answer against the reinforced answer.

In one form of the experiment, which is used in this study, the subjects are tested on whether they can extend the concept which is formed in the learning session to some new tokens. We trained the subjects to respond positively to an oral vowel ([i, e, a, ɔ] respectively in each group) in the learning session, and negatively to others, and observed how they responded to their nasal counterparts ([ĩ, ê, ã, õ]). We assume that if the nasal vowels are distinctive from the oral vowels as traditionally assumed, the subjects should

respond negatively to the nasal vowels. For a more detailed explication of the concept formation experiment paradigm, see Jaeger 1986.

## 2. The experiment

### 2.1 Subjects

Eighty college students were recruited from Freshman English classes at National Tsing Hua University. The students took part in the experiment voluntarily and were tested in groups in the language lab. The subjects indicated in the questionnaire their proficiency of the language. Only the responses from the subjects whose native language was Taiwan Min and who had no prior experience with any romanization systems of Taiwan Min were included in the analysis.

### 2.2 Procedure

The subjects randomly chose their seats in the language lab. Each subject had a tape recorder containing a pre-recorded tape in front of him/her. The tape contained the stimuli for one of four test conditions (see Appendix for a list of stimuli). The four test conditions were [i-ĩ], [e-ê], [a-ã] and [ɔ-õ]. The objective was to train the subjects to respond positively to the target *oral* vowel in the learning session in each condition, and test how they would respond to the *nasal* counterpart of the target vowel. There were 75 stimulus items in each of the conditions. For these 75 items, the first 5 were demonstration items which contained the target oral vowel ([i], [e], [a] or [ɔ]), the next 50 those of the learning session, and the last 20 those of the test session. Each demonstration item, as well as the other 70 items, consisted of a two-syllable word or phrase such that the target sound was easily identified. For example, the subjects in the first condition heard [ti ba] 'pork', and were asked to observe the second sound of the first syllable (which is [i]). The subjects were told that the five demonstration items all contained the sound to be identified, and that the sound appeared at the second position of the first syllable. They were encouraged to make an initial guess at what this target sound might be from these demonstration items.

The next 50 items were the learning session. Among the 50 items, half (25 items) were positive items which contained the target oral vowel ([i], [e], [a] or [ɔ]) in the second position of the first syllable, and the other half were negative items. Seven of the negative items contained irrelevant vowels (3 nasal and 4 oral) in the first syllable, and were used across all four test conditions. The remaining 18 were stimuli from the other three conditions, 6 each, among which 4 were oral and 2 were nasal. In this way, there

were both nasal and oral vowel stimuli in the learning session, although all nasal stimuli were negative tokens.

The items in the learning session were arranged using the same randomization result for all four conditions. That is, where a positive item appeared in one condition, the other three conditions also had a positive item, and the same was true for each of the negative items. This procedure guaranteed that the subjects in all four conditions had the same chance to form the intended concept. An additional constraint also insured that no more than three positive or negative tokens occurred together in succession.

The presentation of each item was as follows: the stimulus was read twice to the subjects, then there was a four-second period of silence on the tape. The subjects were instructed to respond with [u33] (meaning 'yes') or [bo24] (meaning 'no') during this pause to indicate whether they thought the item contained the target sound or not. After the four-second pause, the tape supplied the correct answer, and the subjects were asked to check their response against this feedback and to confirm or modify their assumptions accordingly.

The remaining 20 items constituted the test session. Among these items, 6 were test items which contained the nasal vowel to be tested ([ĩ], [ẽ], [ã] or [õ], respectively). The other 14 items were the reinforcement items which contained 4 positive items with the same stimulus oral vowel ([i], [e], [a] or [ɔ]) as the positive items in the learning session, and 10 negative items which contained none of the critical sounds. Nine of the 20 items in the test session were presented in the same way as those in the learning session; i.e., the stimulus was read twice, followed by a four-second pause, then followed by [u] 'yes' or [bo] 'no'. The other 11 items differed only in the nonappearance of the correct answers ([u] or [bo]) after the pause. These 11 items included all 6 test items, 1 positive reinforcement item and 4 negative reinforcement items. Again, all 20 items were randomized in the same way for all four conditions, with no more than three positive or negative items appearing in a row. The no-feedback items appeared no more than twice in succession, and none of the 6 test items appeared consecutively.

The subjects were told beforehand the way each item was to be presented. They were also told that in the latter part of the experiment, feedback would not be supplied for some of the items. They were told that these items were the test items to see whether they had recognized the sound they were asked to identify. There was no marked break between the learning session and the test session. The subjects' responses were recorded on the stimulus tapes. The experimenter listened to the tapes afterwards and tabulated the responses.

Because of experimental difficulties, the numbers of subjects in each condition were uneven. There were 21 subjects in Conditions 1 and 3 ([i] and [a]), 20 in Condition 2 ([e]), and 18 in Condition 4 ([ɔ]).

## 2.3 Results

Criterion was set at correct responses to 10 consecutive items at any point in the learning session. That means, whenever a subject answered 10 items in a row correctly anywhere in the learning session, he/she is considered to have identified the sound in question. However, due to some mishandling in the recording process, an item (item 31 in the randomized presentation)<sup>1</sup> was not recorded into the tape for Condition 4 ([ɔ̃-õ]). Therefore, the responses to item 31 in all four conditions were deleted from the following analyses. Of the 80 subjects, 50 reached this pre-set criterion. The table in (1) shows the tabulated results.

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(1) Tabulated results of the experiment

A=Number of subjects reaching criterion

B=Percent of subjects reaching criterion

C=Mean number of trials before reaching criterion

D=Ranges of number of trials before reaching criterion

E=Mean number of errors made after reaching criterion in learning session

F=Mean number of items responded to correctly in the learning session

G=Mean number of reinforcement items responded to correctly in the test session

H=Mean number of [u] 'yes' answers to the 6 test items

	A	B	C	D	E	F	G	H
[i-ĩ] (N=21)	12	57%	17.8	10-31	0.75	44.83	13.58	4.83
[e-ẽ] (N=20)	9	45%	15.3	10-27	0.67	46.22	13.78	5.00
[a-ã] (N=21)	16	76%	18.2	10-41	1.13	45.00	13.82	4.75
[ɔ-õ] (N=18)	13	72%	23.9	10-46	2.62	41.46	12.93	4.38
Total (N=80)	50	63%	19.1	10-46	1.34	44.26	13.52	4.72

ANOVA tests:

C:  $F_{(3,46)}=1.83$ ,  $p=.16$ , not significant

E:  $F_{(3,46)}=1.83$ ,  $p=.16$ , not significant

F:  $F_{(3,46)}=2.91$ ,  $p=.04$ , marginally significant

G:  $F_{(3,46)}=3.01$ ,  $p=.04$ , marginally significant

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<sup>1</sup> The item is No. 9 on the unrandomized list. See Appendix.

In this table, ‘mean number of trials before reaching criterion’ (C) means the number of items the subject had done before he/she was able to answer 10 consecutive items correctly. Since the subject had to answer 10 items correctly before he/she was recognized as having reached the criterion, the minimum number is 10, and the maximum number is 49.<sup>2</sup> Table (1) shows that the 12 subjects in Condition 1 who reached criterion did so between the 17<sup>th</sup> and 18<sup>th</sup> items on average (C=17.8). Also among these 12 subjects, some reached criterion from the very beginning (getting the first 10 items correct), and some did it as late as the 31<sup>st</sup> item (D=10-31). After the subjects reached the criterion, they are regarded to have got hold of the concept, and are able to answer the items competently. All errors that occur after the subject reached criterion are regarded as performance errors. These errors are nonetheless recorded in (E) to show that they are rare and are really performance errors.

Among the 80 subjects, 50 reached this preset criterion. The ensuing analyses were based on the responses by these 50 subjects.

The numbers in ‘F’ column show the means of total correct answers given by subjects in the learning session. The highest possible number in this column is 49 (50 items minus item 31), in which case the subject would have answered all 49 items in the learning session correctly. The numbers in ‘G’ refer to the means of total correct answers given to the 14 reinforcement items. The numbers in ‘Test’ show the mean numbers of ‘yes’ answers given to the test items. Since there were 6 test items, the maximum number in this column is 6.

ANOVA tests were then done for the four variables to compare the differences among all four conditions. Although F and G comparisons were marginally significant, Scheffe tests did not show significant differences between any two conditions.

On average, the subjects who reached criterion did so at the 19<sup>th</sup> items (D=10-46). Among the 49 items in the learning session, the subjects answered an average of 44.3 items (91%) correctly. The distribution of the responses by the subjects is shown in the table in (2). (“Null” means that no response was provided by the subjects).

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(2) Number and percent of [u] and [bo] answers made to the items in learning session

Condition 1: [i]	[u] ‘yes’	[bo] ‘no’	Null
Positive items(N=288)	256 (89%)	25 (9%)	7
Negative items(N=300)	15 (5%)	282 (94%)	3
<b>Percent correct=92%</b>			

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<sup>2</sup> Fifty items in the learning session minus item 31.

Condition 2: [e]			
Positive items(N=216)	196 (91%)	17 (8%)	3
Negative items(N=225)	5 (2%)	220 (98%)	0
<b>Percent correct=94%</b>			
Condition 3: [a]			
Positive items(N=384)	349 (91%)	27 (7%)	8
Negative items(N=400)	28 (7%)	371 (93%)	1
<b>Percent correct=92%</b>			
Condition 4: [ɔ]			
Positive items(N=312)	253 (81%)	55 (18%)	4
Negative items(N=325)	36 (11%)	286 (88%)	3
<b>Percent correct=85%</b>			

Of the 14 reinforcement items in the test session, the subjects answered about 13.5 items (97%) correctly (G), which is a great improvement as compared to the learning session. The improvement is due to the learning effect, and is of course expected. The tabulated responses are shown in the table in (3).

(3) Number and percent of [u] and [bo] answers made to the reinforcement items in the test session

Condition 1: [i]	[u] 'yes'	[bo] 'no'	Null
Positive items (N=48)	46 (96%)	2 (4%)	0
Negative items(N=120)	3 (3%)	117 (98%)	0
<b>Percent correct=97%</b>			
Condition 2: [e]			
Positive items(N=36)	35 (97%)	1 (1%)	0
Negative items(N=90)	0 (0%)	89 (99%)	1
<b>Percent correct=98%</b>			
Condition 3: [a]			
Positive items(N=64)	63 (98%)	1 (2%)	0
Negative items(N=160)	2 (1%)	158 (99%)	0
<b>Percent correct=99%</b>			

Condition 4: [ɔ]			
Positive items(N=52)	46 (88%)	6 (12%)	0
Negative items(N=130)	8 (6%)	122 (94%)	0
<b>Percent correct=92%</b>			

As table (1H) shows, of the 6 test items, the subjects accepted about 4.72, on average, and regarded them as belonging to the same concept taught in the learning session. The responses are tabulated in (4).

(4) Number of [u] and [bo] responses made to the 6 test items

	[u] 'yes'	[bo] 'no'	Null
Condition 1: [ĩ] (N=72)	58 (81%)	14 (19%)	0
Condition 2: [ẽ] (N=54)	45 (83%)	9 (17%)	0
Condition 3: [ã] (N=96)	76 (79%)	20 (21%)	0
Condition 4: [õ] (N=78)	57(73%)	21(27%)	0

Table (4) shows that the subjects obviously preferred to consider the nasal vowels to belong to the same category as their oral counterparts, although the percentages of 'yes' answers were not as high as those in (3). In order to test the significance of the differences, we compared the [u] *yes* responses to the test items with those to the **positive** reinforcement items, and we also compared the [bo] *no* responses to the test items with those to the **negative** reinforcement items. Wilcoxon signed-ranks tests were used for this purpose, and the results are shown in (5).

(5) Comparisons of responses to test items against those to reinforcement items.

	[u] vs. positive reinforcement items		[bo] vs. negative reinforcement items	
[ĩ-ĩ]	Z = -2.0226	p = .0431	Z = -3.1275	p = .0018
[ẽ-ẽ]	Z = -1.7691	p = .0769	Z = -2.6941	p = .0071
[ã-ã]	Z = -2.0935	p = .0363	Z = -3.4405	p = .0006
[ɔ-õ]	Z = -2.1477	p = .0317	Z = -3.1886	p = .0014

Among these comparisons, the 'yes' answers to test items are slightly significantly different from those to the positive reinforcement items, except for the second condition [ẽ-ẽ], which is not significantly different. However, the 'no' answers to test answers are all **very** significantly different from those to the negative reinforcement items. This indicates that the subjects' answers to test items were more like positive items than

negative items. The differences between the ‘yes’ and ‘no’ answers to test items can be shown from the following chi-square comparisons.

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(6) Comparisons of [u] and [bo] responses made to the 6 test items

	[u] ‘yes’	[bo] ‘no’	$\chi^2$	<i>p</i>
Condition 1: [ĩ] (N=72)	58	14	26.89	<.001
Condition 2: [ẽ] (N=54)	45	9	24.00	<.001
Condition 3: [â] (N=96)	76	20	32.67	<.001
Condition 4: [õ] (N=78)	57	21	16.62	<.001

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The ‘yes’ answers clearly outnumbered the ‘no’ answers. This result shows that although the nasal vowels did not receive as many ‘yes’ answers as the oral vowels, they tended to be regarded as belonging to the same category as the oral vowels.

### 3. General discussion and conclusion

The results from our experiment indicate that the subjects accepted nasal vowels as belonging to the same category as the oral vowel, although there were differences in acceptance rates. This result is rather unexpected. If in a CV syllable, the locus of nasality is neither in the consonant (as demonstrated in Wang 1996) nor in the vowel (as shown in this experiment), then how is nasality represented underlyingly?

One obvious alternative is for nasality to be represented at the syllable level. Wang 1995 suggests that nasality is an autosegmental feature in Taiwan Min, and that syllables are either nasal or nonnasal. Thus the segments are not significantly nasal or nonnasal, but the syllables are. Li 1986 presents evidence from rhyming in poems and lyrics of songs and argues that nasality is not distinctive segmentally in Taiwan Min. Rather, he suggests that nasality is a suprasegmental feature. Other linguists (e.g., Li 1985, C. H. Tung 1990, Wang 1998) also suggest that nasality is a syllable rather than a segmental feature. In the results obtained from these experiments, evidence seems to point to the reality of such a claim, although we need positive evidence to establish its validity.

## Appendix: Stimuli used in the experiment

The following list contains the stimuli used in the four conditions *before* randomization.

Condition 1: [i-ĩ]	Condition 2: [e-ê]	Condition 3: [a-ã]	Condition 4: [ɔ-õ]
<b>Demo items</b>			
ki55 heŋ24	舉行 se55 sã55	洗衣 ka33 pi55	咖啡 kɔ55 ke21
ti33 baʔ31	豬肉 te33 bi51	茶葉 ca51 p <sup>h</sup> ian21	詐騙 c <sup>h</sup> ɔ51 t <sup>h</sup> aŋ51
gi33 lan24	宜蘭 p <sup>h</sup> e33 cua51	信紙 la33 a51	蚵仔 lɔ21 tiŋ55
bi21 sɔ21	味素 pe21 bu51	父母 c <sup>h</sup> a55 mĩ33	炒麵 tɔ33 te33
c <sup>h</sup> i51 giam33	試驗 ke51 ue33	計畫 ha21 fi55	夏天 kɔ33 po24
<b>Learning session</b>			
<i>Positive items</i>			
1. bi55 kək31	美國 be55 c <sup>h</sup> ai21	買菜 ca55 k <sup>h</sup> i51	早上 cɔ55 sen55
2. ci55 to33	指導 t <sup>h</sup> e55 lat33	體力 ka55 su51	假使 kɔ55 p <sup>h</sup> io21
3. hi55 su33	喜事 ke55 sen55	假仙 la55 paʔ31	喇叭 k <sup>h</sup> ɔ55 kue55
4. k <sup>h</sup> i55 ko55	牙膏 le55 mau33	禮貌 pa55 bin24	飽眠 lɔ55 baʔ21
5. li55 iu24	理由 se55 t <sup>h</sup> au24	洗頭 ka55 c <sup>h</sup> a51	攪吵 pɔ55 cɔ33
6. pi55 kau21	比較 te55 ki24	短期 t <sup>h</sup> ɔ55 te33	土地 ca33 hŋ55
7. c <sup>h</sup> i33 cieŋ24	癡情 k <sup>h</sup> e33 cui51	溪水 k <sup>h</sup> a33 c <sup>h</sup> iu51	手腳 cɔ33 tiũ51
8. hi33 baŋ33	希望 be33 sin21	迷信 pa33 kiət31	巴結 c <sup>h</sup> ɔ33 taŋ33
9. i33 siŋ55	醫生 ge33 k <sup>h</sup> i51	牙齒 ta33 so21	乾燥 ɔ33 c <sup>h</sup> ẽ55
10. k <sup>h</sup> i33 hu33	欺負 ke33 gia33	加額 ka33 tiŋ24	家庭 tɔ33 c <sup>h</sup> i33
11. gi33 sim55	疑心 he33 bi51	蝦米 c <sup>h</sup> a33 piət33	差別 bɔ33 sat31
12. ki33 kuai21	奇怪 le33 c <sup>h</sup> an24	犁田 la33 lian33	拉鍊 hɔ33 tɔ24
13. si33 kan55	時間 pe33 ciũ33	扒養 p <sup>h</sup> a33 baŋ33	拋網 lɔ33 sun51
14. bi21 lai24	未來 ce21 ui33	座位 ba33 sia33	麻針 tɔ21 cai24
15. c <sup>h</sup> i21 tiũ24	市場 ge21 sut33	藝術 c <sup>h</sup> a33 to55	柴刀 cɔ21 kau21
16. gi21 bu33	義務 te21 cu51	地主 ka33 pue33	加倍 gɔ21 hue33
17. li21 pian33	利便 e21 bin33	下面 ha21 pan55	下班 hɔ21 k <sup>h</sup> au51
18. pi21 c <sup>h</sup> u51	備取 he21 t <sup>h</sup> ɔŋ51	系統 ka21 c <sup>h</sup> ui21	咬口 lɔ21 cui51
19. ti21 liau24	治療 le21 gua33	例外 pa21 bian51	罷免 pɔ21 hun33
20. ci51 k <sup>h</sup> i21	志氣 ke51 aŋ55	嫁翁 ca51 io33	炸藥 hɔ51 tau51
21. c <sup>h</sup> i51 kik31	刺激 t <sup>h</sup> e51 uã33	替換 ka51 c <sup>h</sup> e21	教書 kɔ51 su33
22. hi51 kŋ51	肺管 ce51 tɔ33	制度 k <sup>h</sup> a51 iu24	敲油 k <sup>h</sup> ɔ51 t <sup>h</sup> au24
23. i51 kian21	意見 k <sup>h</sup> e51 k <sup>h</sup> i21	客氣 pa51 oŋ24	霸王 pɔ51 te33

24. k <sup>h</sup> i51 iu24	汽油	se51 kai21	世界	la51 sap31	垃圾	so51 zi33	數字
25. t <sup>h</sup> i51 t <sup>h</sup> au24	剃頭	te51 kun33	帝君	pa51 ban33	百萬	t <sup>h</sup> o51 hue33	吐血

*Negative items*

26. t <sup>h</sup> e55 lat33	體力	k <sup>h</sup> i55 ko55	牙膏	k <sup>h</sup> i55 ko55	牙膏	k <sup>h</sup> i55 ko55	牙膏
27. ge33 k <sup>h</sup> i51	牙齒	hi33 baŋ33	希望	hi33 baŋ33	希望	hi33 baŋ33	希望
28. le21 gua33	例外	c <sup>h</sup> i21 tiũ24	市場	c <sup>h</sup> i21 tiũ24	市場	c <sup>h</sup> i21 tiũ24	市場
29. ce51 tɔ33	制度	t <sup>h</sup> i51 t <sup>h</sup> au24	剃頭	t <sup>h</sup> i51 t <sup>h</sup> au24	剃頭	t <sup>h</sup> i51 t <sup>h</sup> au24	剃頭
30. c <sup>h</sup> ẽ33 sik31	青色	fi33 kue51	甜粿	fi33 kue51	甜粿	fi33 kue51	甜粿
31. mẽ21 laŋ24	罵人	mi21 suã21	麵線	mi21 suã21	麵線	mi21 suã21	麵線
32. ca55 k <sup>h</sup> i51	早上	ca55 k <sup>h</sup> i51	早上	t <sup>h</sup> e55 lat33	體力	t <sup>h</sup> e55 lat33	體力
33. ka33 tiŋ24	家庭	ka33 tiŋ24	家庭	ge33 k <sup>h</sup> i51	牙齒	ge33 k <sup>h</sup> i51	牙齒
34. ha21 pan55	下班	ha21 pan55	下班	le21 gua33	例外	le21 gua33	例外
35. k <sup>h</sup> a51 iu24	敲油	k <sup>h</sup> a51 iu24	敲油	ce51 tɔ33	制度	ce51 tɔ33	制度
36. kã33 gak33	監獄	kã33 gak33	監獄	c <sup>h</sup> ẽ33 sik31	青色	c <sup>h</sup> ẽ33 sik31	青色
37. nã33 sik31	藍色	nã33 sik31	藍色	mẽ21 laŋ24	罵人	mẽ21 laŋ24	罵人
38. k <sup>h</sup> o55 kue55	苦瓜	k <sup>h</sup> o55 kue55	苦瓜	k <sup>h</sup> o55 kue55	苦瓜	ca55 k <sup>h</sup> i51	早上
39. tɔ33 c <sup>h</sup> i33	都市	tɔ33 c <sup>h</sup> i33	都市	tɔ33 c <sup>h</sup> i33	都市	ka33 tiŋ24	家庭
40. pɔ21 hun33	部分	pɔ21 hun33	部分	pɔ21 hun33	部分	ha21 pan55	下班
41. t <sup>h</sup> o51 hue31	吐血	t <sup>h</sup> o51 hue31	吐血	t <sup>h</sup> o51 hue31	吐血	k <sup>h</sup> a51 iu24	敲油
42. hõ51 ki24	好奇	hõ51 ki24	好奇	hõ51 ki24	好奇	kã33 gak33	監獄
43. ŋõ55 hiaŋ55	五香	ŋõ55 hiaŋ55	五香	ŋõ55 hiaŋ55	五香	nã33 sik31	藍色
44. bo33 ciŋ24	無情	bo33 ciŋ24	無情	bo33 ciŋ24	無情	bo33 ciŋ24	無情
45. sai55 c <sup>h</sup> ia55	駛車	sai55 c <sup>h</sup> ia55	駛車	sai55 c <sup>h</sup> ia55	駛車	sai55 c <sup>h</sup> ia55	駛車
46. tau21 kuã55	豆干	tau21 kuã55	豆干	tau21 kuã55	豆干	tau21 kuã55	豆干
47. su33 lip33	私立	su33 lip33	私立	su33 lip33	私立	su33 lip33	私立
48. nãi21 sim55	耐心	nãi21 sim55	耐心	nãi21 sim55	耐心	nãi21 sim55	耐心
49. nãũ55 kin55	腦筋	nãũ55 kin55	腦筋	nãũ55 kin55	腦筋	nãũ55 kin55	腦筋
50. mŋ33 k <sup>h</sup> au51	門口	mŋ33 k <sup>h</sup> au51	門口	mŋ33 k <sup>h</sup> au51	門口	mŋ33 k <sup>h</sup> au51	門口

**Test session**

*Test items*

51. ci33 cai24	錢財	cẽ55 cui51	井水	kã33 gak33	監獄	hõ51 ki24	好奇
52. pi51 bin33	變面	c <sup>h</sup> ẽ33 sik31	青色	kã55 co21	敢做	mõ33 pẽ33	毛病
53. fi33 kue51	甜粿	kẽ51 tio21	餓到	sã33 ni24	三年	mõ21 hiam51	冒險
54. t <sup>h</sup> i33 koŋ55	天公	sẽ55 lat33	省力	tã33 pui24	擔肥	mõ33 c <sup>h</sup> at31	摩擦
55. mi21 suã21	麵線	mẽ21 laŋ24	罵人	mã55 co51	媽祖	ŋõ55 hiaŋ55	五香
56. ni33 ko55	尼姑	ne33 sã55	晾衣	nã33 sik31	藍色	ŋõ21 k <sup>h</sup> oŋ55	悟空

*Positive reinforcement items*

57. k <sup>h</sup> i55 taŋ24	起童	e55 a51	矮子	ca33 pɔ55	男人	bɔ55 tan55	牡丹
58. ci33 p <sup>h</sup> io21	支票	c <sup>h</sup> e33 it31	初一	k <sup>h</sup> a55 gi51	巧語	pɔ51 c <sup>h</sup> an24	播田
59. ti21 c <sup>h</sup> ŋ55	痔瘡	se51 han21	細漢	ka33 cua33	蟑螂	tɔ33 c <sup>h</sup> i33	都市
60. ki51 liam33	紀念	e21 hiau51	會曉	p <sup>h</sup> a51 kiu24	打球	hɔ21 su33	護士

*Negative reinforcement items*

61. le55 mau33	禮貌	li55 iu24	理由	le55 mau33	禮貌	le55 mau33	禮貌
62. k <sup>h</sup> a33 c <sup>h</sup> iu51	手腳	k <sup>h</sup> a33 c <sup>h</sup> iu51	手腳	li55 iu24	理由	k <sup>h</sup> a33 c <sup>h</sup> iu51	手腳
63. gɔ21 hue33	誤會	gɔ21 hue33	誤會	gɔ21 hue33	誤會	li55 iu24	理由
64. c <sup>h</sup> o51 bi51	糙米	c <sup>h</sup> o51 bi51	糙米	c <sup>h</sup> o51 bi51	糙米	c <sup>h</sup> o51 bi51	糙米
65. bu55 su33	武士	bu55 su33	武士	bu55 su33	武士	bu55 su33	武士
66. kē51 tio21	髒到	ni33 kɔ55	尼姑	kē51 tio21	髒到	kē51 tio21	髒到
67. kã55 co21	敢做	kã55 co21	敢做	ni33 kɔ55	尼姑	kã55 co21	敢做
68. mǔ33 pē33	毛病	mǔ33 pē33	毛病	mǔ33 pē33	毛病	ni33 kɔ55	尼姑
69. m21 k <sup>h</sup> iŋ51	不肯	m21 k <sup>h</sup> iŋ51	不肯	m21 k <sup>h</sup> iŋ51	不肯	m21 k <sup>h</sup> iŋ51	不肯
70. pŋ21 tiam21	飯店	pŋ21 tiam21	飯店	pŋ21 tiam21	飯店	pŋ21 tiam21	飯店

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