Japanese Psychological Research THE JAPANESE PSYCHOLOGICAL ASSOCIATION

Japanese Psychological Research
2015, Volume 57, No. 1, 61–68
Special issue: Speech sounds across languages
doi: 10.1111/jpr.12064

Constructing initial phonology in Mandarin Chinese: Syllabic or subsyllabic? A masked priming investigation[1]

RINUS G. VERDONSCHOT* *Nagoya University*

JUN LAI *Tilburg University*

FENG CHEN *Chinese Academy of Sciences*

KATSUO TAMAOKA *Nagoya University*

NIELS O. SCHILLER *Leiden University*

Abstract: Recent research has put forward the idea that Chinese speech production is governed by the syllable as the fundamental phonological unit. However, it may be that onset priming might be more difficult to obtain in Mandarin Chinese. Therefore, in this study, the degree of overlap between prime and target was increased from C to CV (i.e., extending beyond the phoneme) as well as whether primes and targets had an overlapping structure (CV vs. CVN). Subsyllabic priming effects were found (i.e., onset + vowel overlap but not purely onset overlap), contrasting with the claim that the syllable is the compulsory building block in the initial construction of Mandarin Chinese phonology.

Key words: fundamental unit, proximate unit, masked priming, language production, Chinese, psycholinguistics.

Speaking requires access to a language's phonology. Interestingly, it has been proposed that the basic unit to build phonology may differ between languages (O'Seaghdha, Chen, & Chen, 2010; Verdonschot et al., 2011). Early evidence for the phoneme as the fundamental building block to construct phonology was obtained using the implicit priming paradigm. Meyer (1990, 1991) showed that while naming a set of response words (in response to prompt words) participants took less time to name the response words when the onsets overlapped (e.g. *dans*, *dop*, *deugd*) compared with when they did not overlap (e.g. *dans*, *heks*, *stoep*). In addition, the effect increased when the overlap increased, but significant priming always needed the onset to overlap (i.e. rhyme words such as: *melding*, *branding*, *scheiding* did not produce significant effects). These results were taken to indicate that the construction of

*Correspondence concerning this article should be sent to: Rinus G. Verdonschot, Graduate School of Languages and Cultures, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan. (E-mail: rinusverdonschot@gmail.com)

[1]This research is supported by a Japanese Society for the Promotion of Science (JSPS) postdoctoral fellowship and Grant-in-Aid for foreign researchers (P12315). This research project was also supported by the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Chinese Academy of Sciences (CAS) through a China Exchange Program grant (11CPD002).

phonology in a language proceeds by incrementally clustering segments into a syllabic metrical frame (WEAVER++; Levelt, Roelofs, & Meyer, 1999). However, using the same paradigm Chen, Chen, and Dell (2002) and O'Seaghdha et al. (2010) did not find significant priming for Mandarin Chinese when just the onset overlapped. As Mandarin Chinese is a tone language (containing four lexically distinctive tones), these authors also ascertained whether tones by themselves yielded implicit priming effects (by comparing atonal syllables and tonal syllables). They found that, although sharing of the first syllable plus tone yielded a slightly larger implicit priming effect (compared with sharing the first syllable without the tone), merely sharing the first segment or tone only (without the syllable) showed no effect. Essentially, these authors only found priming when the syllable completely overlapped, leading to the conclusion that the fundamental (or "proximate" in the terms of O'Seaghdha et al. (2010) unit to initially construct phonology in Mandarin Chinese is the syllable and not the phoneme. Similarly, using the same paradigm, Kureta, Fushimi, and Tatsumi (2006) have shown this to be the mora (and not segment or syllable) in Japanese (see also Verdonschot et al., 2011).

According to O'Seaghdha et al.'s (2010) proposal (which is directly embedded in the language production theory of Levelt et al., 1999), languages differ in the size of the phonological units that are directly connected to the lexeme nodes. These units are to be combined with their metrical frames and/or tones using a unit-to-frame/tone association process that will eventually lead to a phonologically fully specified word. In languages such as Dutch and English, these fundamental units would be phonemes to be put into metrical frames (Levelt et al., 1999), for Japanese they would be moras to be associated with pitch accent (a tonal property; Kureta et al., 2006; Verdonschot et al., 2011), and for Chinese they would be atonal syllables to be associated with tones (Chen et al., 2002; O'Seaghdha et al., 2010).

It could be argued, however, that the aforementioned results might have been influenced by the different typologies used in the languages. For example, Dutch and English use an alphabet (i.e., a script representing phonemes), Chinese uses Hanzi (i.e., logographic characters representing syllables) and Japanese (besides morphemic kanji) uses scripts representing moras (i.e., hiragana and katakana). However, when stimuli are represented in a diverging script (e.g., Japanese moras represented in alphabetic romaji; see Verdonschot et al., 2011; Experiments 2 and 3) or when spoken prompts and picture targets are used (e.g., Chen & Chen, 2013), the aforementioned conclusions still hold. As such, there indeed seems not to be a universal but rather a divergent proximate unit to construct phonology amongst languages.

Using a different paradigm, Ferrand, Segui, and Grainger (1996) showed in French that if the whole first syllable between prime and target overlapped, more priming was observed compared with when it did not overlap. For instance, *pa.lace* (palace, dot denoting the syllable boundary) profited more when it was preceded by a CV prime, for example, /pa/ compared with a CVC prime, for example, /pal/, even though the latter had more overlap in terms of phonemes. However, subsequent studies have had difficulty replicating this effect (e.g., Brand, Rey, & Peereman, 2003) and other studies always found an increasing effect size with more overlap (e.g., Schiller, 1998, 2004). Similar to the study of Ferrand et al. (1996), Chen, Lin, and Ferrand (2003) using masked priming employed disyllabic target words such as CV.GV (/ba4.ye4/) or CVG.CVX (/bay4.ley4/), which were preceded by two types of primes, that is, CV (/ba3/) or CVG (/bay3/). However, Chen et al., 2003 did not include a matched control condition but only included a "neutral" prime, which consisted of an asterisk (which was excluded for later analyses, see Chen et al., 2003, p. 111). They found that when the syllable structure matched (CV-CV.GV, CVG-CVG.CVX;[2] the part before the hyphen (-) denotes the prime and the part after denotes the target), participants were

[2]The part before hyphen (-) denotes the prime (e.g. /ba/) and the part after denotes the target (e.g. /ba4.ye4/, a dot denotes a syllable boundary.

faster compared with when it did not (CV-CVG.CVX, CVG-CV.GX). This occurred even though overlap was greater in, for instance, the CVG-CV.GV compared with the CV-CV.GV condition. Although these are important findings, they do not preclude the potential for subsyllabic priming of both CV-CVG.CVX and CVG-CV.GX (although You, Zhang, & Verdonschot, 2012, Experiment 4, were also unable to find subsyllabic priming for CV-CVN.CVX and CVN-CV.NX when suitable control conditions were included).

The current study is likewise concerned with the size of the phonological unit in Chinese. As mentioned before, there is evidence that the basic unit to construct initial phonology in Chinese is the syllable and not a subsyllabic unit (Chen et al., 2002, 2003; O'Seaghdha et al., 2010). However, other studies have contrasted with these findings, such as Wong and Chen (2009; see also Qu, Damian, & Kazanina, 2012 for electrophysiological evidence) who found in Cantonese Chinese using picture naming with superimposed distracter words that when pictures overlapped in more than a phoneme (e.g., target picture of a 星 /sing1/ "star" with superimposed distracters such as 食 /sik6/ "eat" (CV overlap) and rime overlap distracters such as 境 /ging2/ "boundary" vs. unrelated controls such as 閣 /gok3/ "cabinet") that significant facilitation could still be obtained. This led Wong and Chen (2009) to conclude that the degree of overlap between the target and the distracter may be the determining factor, as subsyllabic overlap also induces facilitation.

The findings of Wong and Chen (2009) are in contrast with a purely syllable based proximate unit assumption (e.g., O'Seaghdha et al., 2010). However, these conflicting results might have been obtained because a different language (Cantonese vs. Mandarin) and different paradigm (picture-word inference instead of implicit priming) were used. Additionally, Wong and Chen (2009) performed their experiments at the Chinese University of Hong Kong (a highly bilingual environment), so it could be put forward that their participants' L2 English proficiency may have been substantial. That L2 proficiency may be an important factor can be seen in a recent study by Verdonschot, Nakayama, Zhang, Tamaoka, and Schiller (2013). These authors recruited highly proficient L1 Mandarin–L2 English bilinguals and using masked priming were able to show onset- and CV-priming not only in English but under certain conditions also in Mandarin Chinese.

In light of the discrepancies in the literature we aim to find out whether or not onset priming might not simply be more difficult to obtain in Mandarin Chinese and therefore whether increasing the degree of overlap from C to CV together with manipulating the structural overlap (particularly for CV-CVN and CVN-CV prime-target combinations) may also show significant priming effects in Mandarin (as shown for Cantonese in Wong & Chen, 2009). To investigate this, we made use of the stimuli from Verdonschot et al. (2013; Chinese part) but instead of using highly proficient bilinguals as they did (thereby showing onset priming in both L2 English and L1 Mandarin), we recruited monolingual Mandarin Chinese participants to assess whether the absence of knowledge of a phoneme-based language (e.g., English) may change the pattern of results (using identical stimuli). If phonological planning for monolinguals is governed by a syllabic proximate unit, we should only find significant priming if the whole syllabic structure overlaps and not for subsyllabic overlap. If we do find priming when the syllabic structure does not match, then this would mean that (at least when using the masked priming task) initial phonological processing is indeed sensitive to subsyllabic units (corroborating with Qu et al., 2012 and Wong & Chen, 2009) and we would need to re-evaluate how exactly priming comes to pass in Chinese speech production.

Method

Participants

Twenty-four undergraduate students (21 female, average age 23.5 ± 1.5 years) participated and were paid approximately US$3.00. They were randomly taken from Beijing Forestry University, China Agriculture University, and Beijing Science and Technology University with the prerequisite that they could not speak English or Japanese. All were native Mandarin Chinese speakers with normal or corrected-to-normal vision. Participants reported that they had no Japanese proficiency at all but unavoidably had some (as English is a mandatory subject at school) limited English proficiency (i.e., average high school grade was 5.7 on a 1–10 scale: 1 = lowest mark, 10 = highest mark). A self-assessment questionnaire (scale: 1 = very poor, 10 = very fluent) showed the following self-assessment scores for four skill categories: Speaking: 4.7, Writing: 5.8, Reading: 6.1, Listening: 5.0. The approximate time (in hours) they spent each day (both at the University and in their private time including music, movies, internet, etc.) facing English was: Speaking: 0.3, Writing: 0.3, Reading: 0.7, Listening: 0.4.

Stimuli

Twenty-four target words were selected (identical to Verdonschot et al., 2013) whereby half adhered to a CV (e.g. /ba/) and the other half to a CVN (e.g. /ban/) structure. Stimuli were constructed such that the tone (a suprasegmental property of Chinese) always overlapped between the target and its primes (see the Appendix). The average log frequency (see Baayen, 2008) was 5.0 ± 1.5 (Chinese Linguistic Data Consortium, 2003) and the number of strokes was on average 8.0 ± 3.1. Primes were selected to match structure (S + = same, e.g., CV-CV, or S– = different, e.g., CVN-CV) and the amount of overlap (O + = onset, O++ = onset + vowel, and O– = control). Stimuli were controlled for log frequency (O + = 4.4 ± 2.1, O++ = 4.4 ± 2.0, O– = 4.8 ± 1.7, $F < 1$) and number of strokes (O + = 10.0 ± 3.2, O++ = 10.4 ± 3.8, O– = 9.6 ± 3.5, $F < 1$). We also made sure to avoid characters with multiple pronunciations and/or semantic or radical overlap.

Design

The experiment adopted a 2 (Structure: same, different) × 3 (Overlap: onset, onset + vowel, control) within-participants design. For instance, the target 八 /ba1/ "eight" could be preceded by: (a) same structure onset overlap prime [S+O+] 逼 /bi1/ "to force," (b) different structure onset overlap prime [S-O+] 宾 /bin1/ "guest," (c) same structure onset + vowel overlap prime [S+O++], 巴 /ba1/ "desire," (d) different structure onset + vowel overlap prime, [S-O++] 班 /ban1/ "class," (e) same structure control prime [S+O-] 趴 /pa1/ "lean, bend over," and lastly, (f) a different structure control prime [S-O-] 攀 /pan1/ "climb."

To avoid excessive repetitions, target-prime combinations were distributed across participants in a Latin-square design such that each participant named each target only three times (instead of 6; i.e., 72 trials overall per participant) although still having encountered all prime types equally often. Each target occurrence was set in one block, resulting in three blocks in total (with short breaks of 30 s between each block and warm-up of three unrelated items per block). The order of target words within a block and the block order itself were randomized for each participant.

Procedure

The experiment was performed using E-Prime 2 Professional Software (Psychology Software Tools). Participants were seated in a quiet room approximately 70 cm from a 21-in. CRT computer screen with a refresh rate of 100 Hz. Naming latencies were measured from target onset using a voice-key connected to the computer via a PST Serial Response Box.

Each trial involved the following sequence: a fixation cross (+) was presented at the center of the screen for 1000 ms, followed by a forward mask (##) for 500 ms; subsequently the prime was presented for 50 ms, followed by the target word which disappeared after 2 s or when the participants made a vocal response. Primes, masks, and targets were presented in 28-point boldfaced Song font. The visual angles of the target words were less than 2 deg both horizontally and vertically. Participants were asked to name the word aloud as quickly and accurately as possible. Following each response, the experimenter judged whether or not the response was correct (or whether a voice key error had occurred). The experiment took approximately 10 min in total.

Table 1 Reaction times and error percentages

	Same structure (S+)	Error (%)	Different structure (S–)	Error (%)
Onset (O+)	520 (55)	1.0	519 (55)	2.1
Onset + Vowel (O++)	497 (47)	1.7	511 (55)	2.1
Control (O–)	520 (64)	1.0	527 (54)	1.7

Note. Standard deviations are shown in parentheses.

Results

Incorrect responses (e.g., nonintended names), other responses caused by microphone errors, and reaction times longer than 1200 ms or shorter than 300 ms (total: 1.4%) were excluded from further data analysis. The remaining data were used in subsequent statistical analyses. As there were few errors (1.6%) equally distributed across conditions, an error analysis was not performed. Regarding the naming latencies: a 2 (Structure: same, different) × 3 (Overlap: onset, onset + vowel, control) repeated measures ANOVA was employed. There was no main effect of Structure, $F_1(1, 23) = 2.54$, $MS_e = 718.1$, $p = .125$, $F_2(1, 23) = 1.15$, $MS_e = 492.2$, $p = .296$, *min* $F'(1, 40) < 1$. This indicates that there was no significant naming latency difference for target words having a CV or CVN structure. However, there was a significant effect of overlap, $F_1(2, 46) = 8.27$, $MS_e = 597.0$, $p < .001$, $F_2(2, 46) = 16.1$, $MS_e = 363.3$, $p < .001$, *min* $F'(2, 83) = 5.5$, $p < .01$, showing naming latency differences according to whether the targets were preceded by onset, onset + vowel, and control primes. There was no interaction between Structure and Overlap, $F_1(2, 46) = 1.1$, $MS_e = 612.2$, $p = .349$, although approaching significance in the items analysis, $F_2(2, 46) = 2.99$, $MS_e = 359.$ 3, $p = .06$, *min* $F'(2, 76) < 1$, indicating that the difference between the three overlap conditions was not dependent on whether the target structure adheres to CV or CVN. To further explore the overlap effect, planned comparisons were carried out. We found no significant difference when comparing the onset, that is, [S+O+] versus control [S+O–], $t_1(23) < 1$, $t_2(23) = 1.7$, $SD = 30.3$, $p = .105$, *min* $F'(1, 24) < 1$ and [S–O+] versus [S–O–], $t_1(23) = 1.0$, $SD = 39.0$, $p = .315$, $t_2(23) = 1.1$, $SD = 26.4$, $p = .270$, *min* $F'(1, 46) < 1$, conditions, but we did find significant differences for the onset + vowel overlap conditions, [S+O++] versus [S+O–], that is, 23 ms facilitation, $t_1(23) = 3.3$, $SD = 34.3$, $p < .01$, $t_2(23) = 5.6$, $SD = 27.1$, $p < .001$, *min* $F'(1, 37) = 8.1$, $p < .01$, and [S–O++] versus [S–O–], that is, 16 ms facilitation, $t_1(23) = 3.2$, $SD = 23.8$, $p < .01$, $t_2(23) = 2.3$, $SD = 27.0$, $p < .05$, *min* $F'(1, 42) = 3.5$, $p = .07$. See Table 1 for an overview of the results.

Discussion

Form-priming effects in reading aloud were investigated in the current study. This study specifically sought to find out whether the unit to construct phonology in Chinese depends on the exact syllable match between prime and target or whether altering the overlap between prime and target without adhering to the full syllabic overlap may also show significant priming. Our data showed that strict syllabic overlap between prime and target is not a necessary condition to obtain facilitation in Chinese. We did find substantial priming for identity primes (CV-CV and CVN-CVN, e.g., /ba1/-/ba1/, /ban1/-/ban1/ vs. controls) but, crucially, we also found significant priming when the syllabic structure did not overlap (CV-CVN, CVN-CV, e.g., /ba1/-/ban1/ and /ban1/-/ba1/ vs. controls). Interestingly, the effect size was not different by participants, $t_1(23) < 1$, but only by items, $t_2(23) = 2.3$, $SD = 38.4$, $p < .05$, *min* $F'(1, 28) < 1$. We also assessed whether significant priming for nonsyllabic overlapping combinations was not simply caused by the CVN-CV prime-target combinations (although the structure is different, the prime in terms of segments overlaps fully with the target and not partially, as in the CV-CVN combinations). Therefore, we analyzed only the [S–O++] versus [S–O–] conditions for both CVN-CV and CV-CVN type combinations (with combination being a between-item variable). We found a significant effect of combination, with CVN-CV combinations being 14 ms faster compared with CV-CVN by participants, $F_1(1, 23) = 7.5$, $MS_e = 616.9$, $p < .05$, but not by items, $F_2 < 1$, *min* $F'(1, 26) < 1$, and a significant effect of overlap with O++ overlap being 16 ms faster than the O– condition, $F_1(1, 23) = 11.8$, $MS_e = 539.9$, $p < .01$, $F_2(1, 22) = 5.2$, $MS_e = 377.5$, $p < .05$, *min* $F'(1, 39) = 3.6$, $p = .07$, but no interaction between combination and overlap, all Fs < 1. Therefore, the effect holds for both the CV-CVN and CVN-CV overlap combinations.

Chen et al. (2002) and O'Seaghdha et al. (2010) have used experimental stimuli either overlapping in the onset or the whole syllable. Our results indicated that it might be worthwhile for future investigations to extend their results by adding another condition similar to the current experiment (nonsyllabic but more than an onset overlap). This might potentially reveal significant priming. We would like to point out that the current results at this time do not warrant the conclusion that the fundamental unit in Chinese language production is CV. Additional research (including independent replications) is needed to corroborate these findings and it might be worthwhile to even look at larger overlap priming in Chinese (e.g., two vs. three segments in four-segment targets). We would also like to put forward that bilingual research also constitutes an important avenue for future investigations concerning the structure of the fundamental phonological unit. For instance, would Japanese-Chinese bilinguals show CV or V-priming (both moras in Japanese) but not initial C-priming in their L2 Chinese?

Our findings diverged from the results of Verdonschot et al. (2013), who used identical stimuli, in that the onset condition (O+) in our study never showed significant priming (which was observed for their proficient bilinguals). Therefore, the conclusion of Verdonschot et al. (2013) that onset priming even in Mandarin Chinese was caused by Chinese-English bilinguals having a good command of English is not invalidated (as our participants can be considered monolinguals or at most having very poor English proficiency).

In conclusion, the current findings are difficult to match with the claim that the syllable is the obligatory building block in the initial construction of Mandarin Chinese phonology, because in that case nonsyllabic overlapping combinations would not have shown any priming (and/or a significant interaction). Our findings are therefore currently better explained by advocating some form of the degree of overlap hypothesis (e.g., Schiller, 1998, 2004; Wong & Chen, 2009). However, due to the mixture of findings in the literature, replications and extensions of the current (and previous) findings are needed to specify the exact conditions under which subsyllabic priming is either present or absent.

References

Baayen, R. H. (2008). *Analyzing linguistic data. A practical introduction to statistics using R*. Cambridge, UK: Cambridge University Press.

Brand, M., Rey, A., & Peereman, R. (2003). Where is the syllable priming effect in visual word recognition? *Journal of Memory and Language*, *48*, 435–443.

Chen, J.-Y., Chen, T.-M., & Dell, G. S. (2002). Word-form encoding in Mandarin Chinese as assessed by the implicit priming task. *Journal of Memory and Language*, *46*, 751–781.

Chen, J.-Y., Lin, W.-C., & Ferrand, L. (2003). Masked priming of the syllable in Mandarin Chinese speech production. *Chinese Journal of Psychology*, *45*, 107–120.

Chen, T.-M., & Chen, J.-Y. (2013). The syllable as the proximate unit in Mandarin Chinese word production: An intrinsic or accidental property of the production system? *Psychonomic Bulletin and Review*, *20*, 154–162.

Chinese Linguistic Data Consortium. (2003) 现代汉语通用词表 [*Chinese Lexicon*] (*CLDC-LAC-2003–01*). Beijing, China: State Key Laboratory of Intelligent Technology and Systems, Tsinghua University, and Institute of Automation, Chinese Academy of Sciences.

Ferrand, L., Segui, J., & Grainger, J. (1996). Masked priming of word and picture naming: The role of syllabic units. *Journal of Memory and Language*, *35*, 708–723.

Kureta, Y., Fushimi, T., & Tatsumi, I. F. (2006). The functional unit of phonological encoding: Evidence for moraic representation in native Japanese speakers. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *32*, 1102–1119.

Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, *22*, 1–75.

Meyer, A. S. (1990). The time course of phonological encoding in language production: The encoding of successive syllables of a word. *Journal of Memory and Language*, *29*, 524–545.

Meyer, A. S. (1991). The time course of phonological encoding in language production: Phonological encoding inside a syllable. *Journal of Memory and Language*, *30*, 69–89.

O'Seaghdha, P. G., Chen, J.-Y., & Chen, T.-M. (2010). Proximate units in word production: Phonological encoding begins with syllables in Mandarin Chinese but with segments in English. *Cognition*, *115*, 282–302.

Qu, Q., Damian, M. F., & Kazanina, N. (2012). Sound-sized segments are significant for Mandarin speakers. *Proceedings of the National Academy of Sciences*, *109*, 14265–14270.

Schiller, N. O. (1998). The effect of visually masked syllable primes on the naming latencies of words and pictures. *Journal of Memory and Language*, *39*, 484–507.

Schiller, N. O. (2004). The onset effect in word naming. *Journal of Memory and Language*, *50*, 477–490.

Verdonschot, R. G., Kiyama, S., Tamaoka, K., Kinoshita, S., La Heij, W., & Schiller, N. O. (2011). The functional unit of Japanese word naming: Evidence from masked priming. *Journal of Experimental Psychology: Learning, Memory and Cognition.*, *37*, 1458–1473.

Verdonschot, R. G., Nakayama, M., Zhang, Q. F., Tamaoka, K., & Schiller, N. O. (2013). The proximate phonological unit of Chinese-English bilinguals: Proficiency matters. *PLoS ONE*, *8*, e61454.

Wong, A. W.-K., & Chen, H.-C. (2009). What are effective phonological units in Cantonese spoken word planning? *Psychonomic Bulletin and Review*, *16*, 888–892.

You, W. P., Zhang, Q. F., & Verdonschot, R. G. (2012). Masked syllable priming effects in word and picture naming in Chinese. *PLoS ONE*, *7*, e46595.

(Received October 17, 2013; accepted May 10, 2014)

Appendix

Stimuli

Target	Prime					
	Structure+ Onset (O+)	Structure+ Full (O++)	Structure+ Control (O–)	Structure– Onset (O+)	Structure– Full (O++)	Structure– Control (O–)
ba1 八	bi1 逼	ba1 巴	pa1 趴	bin1 宾	ban1 班	pan1 攀
ban1 搬	bin1 宾	ban1 班	pan1 攀	bi1 逼	ba1 巴	pa1 趴
hu1 乎	ha1 哈	hu1 忽	tu1 突	han1 憨	hun1 荤	tun1 吞
hun1 昏	han1 憨	hun1 荤	tun1 吞	ha1 哈	hu1 忽	tu1 突
sha1 杀	she1 奢	sha1 沙	cha1 插	shen1 身	shan1 删	chan1 搀
shan1 山	shen1 身	shan1 删	chan1 搀	she1 奢	sha1 沙	cha1 插
xi1 西	xu1 需	xi1 息	qi1 七	xun1 熏	xin1 新	qin1 亲
xin1 心	xun1 熏	xin1 新	qin1 亲	xu1 需	xi1 息	qi1 七
ya1 鸭	yu1 迂	ya1 压	ta1 他	yun1 晕	yan1 淹	tan1 贪
yan1 烟	yun1 晕	yan1 淹	tan1 贪	yu1 迂	ya1 压	ta1 他
cha2 茶	chu2 除	cha2 察	na2 拿	chun2 纯	chan2 馋	nan2 男
chan2 缠	chun2 纯	chan2 馋	nan2 男	chu2 除	cha2 察	na2 拿
pi2 皮	pa2 爬	pi2 啤	mi2 迷	pan2 盘	pin2 频	min2 民
pin2 贫	pan2 盘	pin2 频	min2 民	pa2 爬	pi2 啤	mi2 迷
qi2 奇	qu2 渠	qi2 其	li2 离	qun2 群	qin2 琴	lin2 林
qin2 秦	qun2 群	qin2 琴	lin2 林	qu2 渠	qi2 其	li2 离
zhe3 者	zhu3 煮	zhe3 褶	re3 惹	zhun3 准	zhen3 诊	ren3 忍
zhen3 枕	zhun3 准	zhen3 诊	ren3 忍	zhu3 煮	zhe3 褶	re3 惹
ba4 罢	bi4 必	ba4 霸	ta4 踏	bin4 殡	ban4 办	tan4 探
ban4 半	bin4 殡	ban4 办	tan4 探	bi4 必	ba4 霸	ta4 踏
du4 肚	da4 大	du4 渡	gu4 顾	dan4 蛋	dun4 盾	gun4 棍
dun4 顿	dan4 蛋	dun4 盾	gun4 棍	da4 大	du4 渡	gu4 顾
la4 辣	lu4 鹿	la4 腊	ma4 骂	lun4 论	lan4 滥	man4 慢
lan4 烂	lun4 论	lan4 滥	man4 慢	lu4 鹿	la4 腊	ma4 骂