L1 and L2 Respiratory Patterns of Chinese and English

Bilinguals’ Read Speech

YANG Jin, KONG Jiangping*

Abstract
This paper investigated the respiratory patterns of native English and Chinese’s bilinguals in the read speech material of both languages. Experiments are conducted by respiratory belts, to measure breast breath signal, abdomen breath signal and the accumulated breath signal of the two. Results showed that speakers tend to adopt different breath patterns in L1 and L2 and tend to borrow their L1 respiratory pattern into their L2 processing strategy. Results also show that this borrowing seems to be positively correlated with their L2 oral proficiency. These findings have implications for respiratory signal processing, prosodic typology, bilingualism and second language acquisition.

KeywordS: respiratory pattern; rhythm; respiratory belt

1. Introduction
Since the introduction of the Pitch Accent Theory (Bolinger, 1958) [1], most researchers have come to an agreement that pitch is the most important factor in perceiving heaviness. The nowadays popular ToBI labeling system is itself based on this framework. The main trend has been regarding rhythm as LH alternations. In other words, rhythm refers to the regular strong-weak, or, long-short alternation pattern. Language rhythm is the periodical impulses at suprasegmental level. This regular pattern is otherwise one fundamental property of prosody.

Rhythmic patterns vary across languages. Lloyd James (1940, cited by Pike, 1945) [2] attributed the prosodic difference between Spanish or Italian and English or Dutch. He used the metaphor “machine-gun rhythm” for the first group of languages and “Morse code rhythm” for the second. Actually it also depends on different prosodic levels, how they’re defined and how they’re organized together. In Chinese Putonghua, most researchers have a consensus that there is a rhythmic unit a level above syllable – two-syllable cluster or three-syllable cluster.

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Thus an experiment is conducted by using respiratory belts to measure the respiratory patterns of Chinese and English bilinguals either at Chinese or English read speech.

2. Method

2.1 Participants

Four English and Chinese bilinguals participated in this experiment. They are one male and one female native American English speakers and one male and one female native Beijing dialect speakers. The male native American English speaker is a graduate student of Chinese at Peking University and the rest three speakers are undergraduate students of Peking University at the time of the recording. The male native American English speaker has quite high Chinese proficiency and is therefore regarded as advanced learner of Chinese. The female native American English speakers has arrived at Peking University for a year and two months to study Chinese. She is regarded as a preliminary learner of Chinese. The two undergraduate Chinese students are local Beijingers. They speak Beijing Mandarin whose phonetic system is the basis of Standard Chinese, Chinese Putonghua, the official language of China. As for the English proficiency of Chinese undergraduates, since oral proficiency is not surely positively correlated with written language proficiency, we invited Oral English teachers to evaluate their spoken proficiency. The male undergraduate is judged as mid-low level and the female undergraduate mid-high level, hence preliminary and advanced in accordance with the English speakers.

Each subject recorded two sets of data, in Chinese or English. None of subjects reported having any speech disorders. All subjects received payment.

2.2 Material

An English novel excerpt and a Chinese novel excerpt are selected as read speech material. The English material is taken from Harry Potter “Chapter Six: The Journey From Platform Nine and Three-Quarters”, 299 words in total.

The Chinese material is taken from Miscellaneous Stars, 198 words in total.

2.3 Recording Procedure

All recordings took place in a sound-proof room in the Phonetics Lab, Department of Chinese Language and Literature, Peking University. The main recording equipment is a 16 bit myoelectric graph and electroencephalograph information gatherer produced by Australia Powerlab Company. The recording software is Chart 5 which is carried by the equipment itself. Recording collects four channels of signals: 1) sound file collected by Sony microphone; 2) graph collected by EGG produced by Kay Corporation; 3) abdomen breath signal collected by MLT1132 respiratory belt; and 4) breast breath signal collected by MLT1132 respiratory belt. The four channels of signals are used for analysis. EGG has no special requirement for sampling rate. In order to enable MATLAB software procedure to run fast, the sampling rate is fixed at 20 kHz and EGG signal is fixed as high-pass above 50Hz to avoid neck artery pulse disturbance.

2.4 Results & Analysis

Exact respiratory contour are shown in the following figures. Each figure contains three channels of signals – breast breath, abdomen breath and the accumulated two. The range of each window is the same 16s.

Figure 1. The male native American English speaker read English novel

Figure 2. The male native American English speaker read Chinese novel

Fig. 1 and Fig. 2 are English and Chinese novel read by a male native American English speaker. In the same 16s range shown in the pane, Chinese material contain more breath resets, either breast or abdomen ones than its English counterpart. For each breath reset, the Chinese breath tilt rate is more rapid than...
the English one. The Chinese breath reset peak is also higher than the English one. Both figures contain low resets which indicate strong and sudden exhales.

Fig. 3 and Fig. 4 are English and Chinese novel read by a female native American English speaker. The comparison between the two figures showed a similar situation as for breath reset numbers. However, unlike the male native English speaker, the female speaker doesn’t show a more rapid tilt rate and higher reset peak. Rather, both Fig. 3 and Fig. 4 are similarly flat. We later found this is due to the poor oral Chinese proficiency of the subject. Since in the same time range of 16s, she uttered less Chinese syllables, hence the slower tempo led to a more moderate tilt rate. Like the previous case, both figures contain low resets which indicate quite strong and sudden exhales.

Fig. 5 and Fig. 6 are Chinese and English novel read by a female native Chinese speaker. Again, Chinese material contain more breath resets, either breast or abdomen ones than its English counterpart. For each breath reset, the Chinese breath tilt rate is more rapid than the English one. The Chinese breath reset peak is also higher than the English one. Unlike native English speakers, low resets are not witnessed.

Fig. 7 and Fig. 8 are Chinese and English novel read by a male native Chinese speaker. Again, Chinese material contain more breath resets, either breast or abdomen ones than its English counterpart. Inhale peaks are high and obvious. Very clear triangular-shaped tilt is witnessed. English material breath tilt rate is long and more flat than Chinese material. Only one low dent is witnessed.

3. Analysis and discussion

The respiratory patterns can be summarized in a general statistics shown in the following table, Tab. I. The eight rows record different speakers’ signals, identified by the name. For example, “M_AmS_En” means male native American student reading English speech and “F_ChS_Ch” means female native Chinese student read Chinese speech. The three columns stand for signals from the three channels. BBRs stand for Breast Breath Resets, ABRs stand for Abdomen Breath Reset numbers and the third column stand for the accumulation of the two. The numbers in brackets are for minor ups or downs.
TABLE I. BREATHE UNITS COUNT

<table>
<thead>
<tr>
<th></th>
<th>BBRs</th>
<th>ABRs</th>
<th>accumulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>M_AmS_En</td>
<td>4(1)</td>
<td>4</td>
<td>4(1)</td>
</tr>
<tr>
<td>M_AmS_Ch</td>
<td>6(1)</td>
<td>5(1)</td>
<td>6(1)</td>
</tr>
<tr>
<td>F_AmS_En</td>
<td>4(1)</td>
<td>5(2)</td>
<td>5(1)</td>
</tr>
<tr>
<td>F_AmS_Ch</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>F_ChS_Ch</td>
<td>7</td>
<td>6(2)</td>
<td>7(1)</td>
</tr>
<tr>
<td>F_ChS_En</td>
<td>6</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>M_ChS_Ch</td>
<td>5(2)</td>
<td>5(2)</td>
<td>5(2)</td>
</tr>
<tr>
<td>M_ChS_En</td>
<td>4(2)</td>
<td>4(2)</td>
<td>4(2)</td>
</tr>
</tbody>
</table>

Based on this table, we can reach the following results.

The first, breath has units. It can be divided into different tiers, from very small to very big, changing from an axis. As earlier researches (J. J. Tan, 2008) [12] has found there are three tiers of breath in speech in a Chinese news read speech study, we here claim that there might be more tiers depending on different languages and the calculation accuracy.

The second, speakers adopt regular/fixed respiratory patterns in uttering speech of certain languages since numbers in the three columns don’t differentiate much.

The third, major and minor (or even more minor breath levels can be classified since we can broaden the time range in combination with a more detailed calculation of different levels of resents or peaks) breaths coexist, but not in a regular alternation pattern. It is inferred that this is correlated with different tiers of phonological units in a language typology, also decided by syllable numbers within a respiratory unit and tempo.

The fourth, males have more minor breaths than females, or in other words, males adopt more major-minor breath alternation in uttering speech.

The fifth, there are generally more breath units in Chinese read speech, which doesn’t vary across L1 and L2 speakers of either Chinese or English. It is inferred that Chinese is a syllabic language while English is a mora language.

The sixth, Chinese and English has very different respiratory patterns. Chinese is more highlighted by inhale resets (which indicates the inhaling moment) while English is more highlighted by exhale resets (which indicates the exhalation moment).

The seventh, Chinese takes a “Strides & Swift-paced” respiratory pattern while English takes a “Moderate-Equal Step” respiratory pattern. Namely, Chinese breast breath appears to be a skewed big triangle of major breath enclosing several small triangles of minor breaths. English takes almost equal length respiratory steps of normal distribution.

The eighth, speakers adopt a combination of L1 and L2 language respiratory pattern in uttering L2 read speech. This is due to a hybrid of L1 respiratory pattern and an unconscious process confined by L2 phonological and syntactical information.

Sometimes L2 effect transfers as is witnessed in Fig. 6 where the red arrow indicates that a typical exhale reset respiratory feature of English is adopted by the female native Chinese speaker while uttering English speech.

Finally there’s one point worth to mention. Since each level of learners, medium-high and medium low, contains only one speaker, it seems that sex factor is not effectively balanced in this experiment design. However we argue that since male and female speakers, if belong to a same L1 group or L2 group, do not vary much in their respiratory performance, sex factor does not play a significant role in this case.

Results show that speakers tend to borrow their L1 respiratory pattern into their L2 processing strategy. Results also show that this borrowing seems to be negatively correlated with their L2 oral proficiency. The higher the language proficiency, the less borrowing happens. We hope these findings have implications for prosodic typology, bilingualism and second language acquisition.

4. CONCLUSION

This respiratory belt study indicates that Chinese takes a “Strides & Swift-paced” respiratory pattern which contains obvious major and minor breaths while English takes a “Moderate-Equal Step” respiratory pattern. Chinese language reflects high breast breath inhale resets at the left boundary of prosodic segments while English language tends to have more moderate resets and lower exhale resets. Speakers tend to borrow their L1 respiratory pattern into their L2 processing strategy. Results also show that this borrowing seems to be negatively correlated with their L2 oral proficiency. The higher the speakers’ proficiency, the less borrowing there is. Thus it provided a phonation evidence for narrow focus phonetic representation as well as a quantified description of rhythmic patterns of Chinese and English.

However, there are also limitations and further requests for future research. We only include breast breaths and abdomen breaths in a same 16s range within one pane in our work by respiratory belt. Syllable numbers and tempo is not taken into
consideration in our current thesis, and they are also significant prosodic referents. Statistics is another consideration in future research so as to verify our findings in a more technical and convincing way. The above-mentioned aspects are to be supplemented in our future research on respiration.

5. Acknowledgment

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6. References