RESPIRATION FEATURES OF CHINESE LEARNERS UNDER SELF-NARRATION TASK

——the case of learners from Korea,Japan,America and Thailand

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Abstract*—Through the methods of physiological experiment in combination with acoustical experiment, the present research investigates the respiration and acoustic features of the Chinese learners during the task of self-narration. Twenty-four Chinese learners from Korea, Japan, America and Thailand are assigned to narrate in Mandarin Chinese. The spontaneous speech respiration which is greatly influenced by the physiological condition, cognitive processing, context and mood state tends to make the respiration curve to be complex. In this condition, compared with Chinese native speakers, different respiratory units have significant differences in inspiration/expiration duration, amplitude and slope in terms of respiratory parameters. The frequency of the abnormal pause is large in great extent, and the position of the abnormal pause is rather flexible, so its different categories correspond to the different respiration forms.

***Keywords*—Respiration parameter;Respiration curve;Pause**

I. INTRODUCTION

Previous researches proposed that speaking and respiration during spontaneous speech show a corresponding relation, e.g.,Yuan and Li [1] examined the characteristics of respiratory section during emotional speech under the state of loud reading and free talk; and Zhang [2] investigated the relationship between respiratory rhythm and speech rhythm during discourse self-narration It is different from the above two studies, Wang et al. [3] focused on the difference of respiratory group in terms of duration and F_0 under the state of loud reading and free talk. In regards with the relation between pause and respiration, Liu [4] considered that narrators use different pause marks during free talk to solve the problem of real-time conception produced by language. Tseng [5] examined several common filled pauses in free talk. Yuan and Li [6] examined the phenomenon of abnormal pause in spontaneous speech. Lieberman and Michaels [7] pointed out that respiratory pattern changes with the emotional state of speaker and preplanning failure might occur during speech. From the overview of the previous study, it can be obtained that previous study mainly discussed the relation between the respiration state and the emotional speech. The relation between the respiration and the production of pauses are also concerned. The present study intends to reveal respiratory parametric representation during speech, i.e., characteristics of respiratory curve and speech pause characteristics of Chinese learners under self-narration task with experimental method.

II. DESCRIPTION OF EPERIMENT

A. Experiment method

Twenty-four Chinese learners (twelve male and twelve female) whose Chinese level reached intermediate level were selected as the subjects in this experiment. The average age of are 24.5 and they show no respiratory diseases and speech disorder. They were instructed to introduce themselves for about one minute at normal speed during experiment. The experiment was conducted in a quiet environment at the lab of Nankai University.

B. Calculation and statistics of respiration parameters

Six parameter indexes were adopted in this experiment which include inspiration duration, amplitude, slope, expiration duration, amplitude and slope. The parameters are illustrated in the following figure1. The inspiration section shows the rise curve; the expiration section displays the descent curve. The abscissa axis T means the duration, where Ti is inspiration duration and Te is expiration duration. The vertical axis C means the amplitude, where Ci is inspiration amplitude and Ce is expiration amplitude. Pn is a peak value; Vn-1 is prior peak-valley value and Vn is rear peak-valley value.

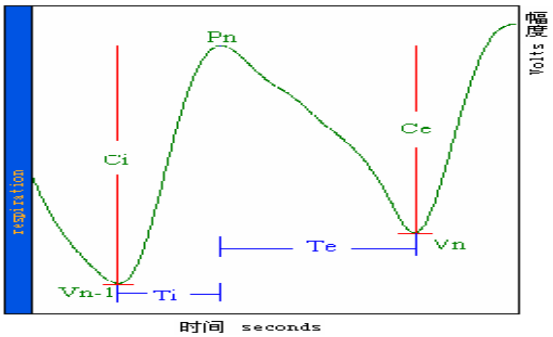

Fig. 1. Respiration curve example

The computational formulas of each parameter in the above figure are as follows:

Inspiration duration: Ti= Tpn - Tvn-1 (1)

Expiration duration: Te= Tvn - Tpn (2)

Inspiration amplitude: Ci= Cpn - Cvn-1 (3)

Expiration amplitude: Ce= Cpn - Cvn （4）

The absolute respiration amplitude is relativized.

H =（P-Vmin）/（Pmax-Vmin） （5）

P is the respiration amplitude of a point, and Pmax is the maximum peak in the whole respiration curve of a subject; Vmin I the minimum valley value of the whole respiration curve. Thus, the following can be obtained:

Inspiration slope: Ki=Ci/Ti=(Hpn-Hvn-1)/Ti （6）

Expiration slope: Ke=Ce/Te=(Hvn–Hpn)/Te （7）

According to the rise & drop features and the difference between peak and valley, the respiration curve is classified into three categories: respiration group, respiration segment and respiration section. The respiration group displays the full respiration, i.e., the part with H value of peak-valley difference over 0.5; the respiration segment shows semit-respiration, i.e., the part with H value of peak-valley difference between 0.2 and 0.5; the respiration section shows tiny respiration, i.e., the section with H value of peak-valley difference below 0.2 [8].

C. Collection, extraction and statistics of data

The respiration data is collected by MP150 data collection system (BIOPAC Systems MP150) produced by BIOPAC. Data is extracted and analyzed by the software Acqknowledge3.9 of the instrument. Audacity software is adopted to record the voice of the subjects while the respiration is collected. The audio sample rate is 11025Hz (16-bit single track). Praat software is adopted to analyze acoustics features of the speech. SPSS is further adopted for statistics of experimental data.

III. RESPIRATION PARAMETERS AND CURSE CHARACTERISTICS

A. Representations of respiratory unit at various levels

In regards with the parameter of inspiration, the inspiration duration can reflect the pause length and the inspiration amplitude can reflect preset air flow. According to relevant researches, the preset duration and preset air flow can show the length of the subsequent sentence in advance [9]; The positive inspiration slope means that the inspiration speed and slope value is larger; faster inspiration speed stands for the steeper gradient. Through calculation, we obtain mean respiration duration, respiration amplitude and respiration slope of twenty-four subjects.

TABLE I. Table of mean duration, amplitude and slope (Chinese learners)

	Respiration group		**Respiration segment**		**Respiration section**	
	M	**Sd**	**M**	**Sd**	**M**	**Sd**
Inspiration duration (s)	0.79	0.36	0.71	0.24	0.48	0.26
Inspiration amplitude (H value)	0.55	0.24	0.48	0.22	0.22	0.14
Inspiration slope	0.70	0.29	0.67	0.25	0.46	0.18
Expiration duration (s)	1.61	0.29	1.27	0.23	0.83	0.16
Expiration amplitude (H value)	0.39	0.25	0.31	0.23	0.18	0.17
Expiration slope	0.25	0.15	0.23	0.14	0.20	0.12

Representation of respiratory unit at each level: The following characteristics can be seen from table I - maximum duration, amplitude and slope of inspiration and expiration of respiration group; minimum duration, amplitude and slope of inspiration and expiration before respiratory section; various parameters before respiration segment respectively between respiration group and respiratory section; in terms of parameter distribution interval, the duration, amplitude and slope of each respiratory unit have a high standard deviation and their data are scattered with overlapping part.

Specifically, respiration group and respiration segment are similar in terms of the duration of inspiration; however, the duration decreases significantly from the respiration part to the respiratory part. Therefore, overseas students of these four countries, i.e., Korea, Japan, America and Thailand have similar pauses in respiratory group and before respiratory segment and short pause before respiratory section; the duration decreases significantly from respiratory group to respiratory section in terms of the duration of inspiration; as for inspiration amplitude, respiratory section has the minimum amplitude, which indicates that its following sentences are short; in regards with expiration amplitude, respiratory section has the minimum amplitude which show that the expiratory volume is minimum in respiratory section, and it is related to the small number of syllables corresponding to respiratory section; as for the inspiration slope, respiratory group and respiratory segment are similar and data of respiratory section decrease significantly; in terms of expiration slope, mean values of each respiratory unit do not differ much.

B. Comparison of parameters of respiratory units at each level between Chinese learners and native Chinese speakers

We compared mean values of respiratory parameters between twenty-four Chinese learners and ten native Chinese speakers [10] to investigate the similarities and differences.

TABLE II. Table of mean duration, amplitude and slope (native speakers)

	Respiration group		**Respiration segment**		**Respiration section**	
	M	**Sd**	**M**	**Sd**	**M**	**Sd**
Inspiration duration (s)	0.66	0.20	0.59	0.15	0.53	0.15
Inspiration amplitude (H value)	0.33	0.23	0.28	0.21	0.16	0.22
Inspiration slope	0.49	0.29	0.45	0.29	0.28	0.31
Expiration duration (s)	2.00	1.28	1.87	1.08	1.55	1.23
Expiration amplitude (H value)	0.30	0.23	0.28	0.23	0.21	0.21
Expiration slope	0.17	0.14	0.15	0.10	0.15	0.16

Under the self-narration task, the respiration levels and respiration parameters of Chinese learners and native Chinese speakers show the same points: the size of respiratory units is in direct proportion to respiration duration, amplitude and the slope; and it can be seen from parameter distribution interval, standard deviations of respiration duration, amplitude and the slope of each respiratory unit are large.

Some significant differences can be obtained from data comparison: From respiration duration, the inspiration duration of Chinese learners before the respiration group and respiration segment is longer than that of native Chinese speakers; the inspiration duration of Chinese learners before the respiration section is slightly shorter than that of native Chinese speakers. Besides, parameter values from respiration group and respiration section drop more significantly. This result indicates that the pause of Chinese learners before large respiratory unit is longer than that of native speakers. Seeing from inspiration amplitude, the amplitude values of Chinese learners at each respiratory unit are larger than those of native Chinese speakers. This result means that the aspiratory capacity of learners is larger. Seeing from inspiration slope, the respiration slope of Chinese learners is much larger than that of native Chinese speakers. This also shows their inspiration rate is faster. In regards with expiration duration, the expiration duration of Chinese learners on the respiration group, respiration segment and respiration section is obviously shorter than that of native speakers, especially on the respiration section. This shows utterance length of Chinese learners is shorter than that of native speakers. Seeing from expiration amplitude, the amplitude values of Chinese learners on the respiration group and respiration segment are larger than those of native speakers, and the amplitude on the respiration section is smaller. This indicates expiration capacity of Chinese learners on the respiration group and respiration segment is larger and smaller on the respiration section. From the expiration slope, it can be seen that learners at each respiratory unit is larger than that of native speakers. This indicates their expiration speed is faster.

C. Characteristics of respiratory curves

The respiratory curve of a discourse is composed of various respiratory sections of different sizes; each respiratory section is composed of curves with different fluctuation change and slopes. Generally, on the respiratory curve, the inspiration part is divided into sharp rise, slow rise and flat rise; the expiration part shows sharp drop, slow drop and flat drop. Totally, there are six types. Seeing from the inspiration part, inspiration directly reaches the peak with the same slope. During inspiration, the situations where the slope varies are few. The position and verbal information of different types of inspiratory curves are different. Roughly speaking, the sharp-rise curves often marks that there will be a long speech segment later. It occurs roughly before the respiration group and is the mark of a sentence. Some occur before the respiration segment and are the marks of sub-sentence. Sometimes, sharp-rise curve will correspond to a large pause as the completion mark of the semantic meaning of the previous phrase. Slow-rise curve are mostly appeared before the respiration segment. It is not just the starting mark of a sub-sentence, but also the ending mark of a sub-sentence. Slow-rise type is also one of pause representations. The corresponding pauses are mostly the pauses between sub-sentences. Flat-rise curve generally appears before the respiration section. It is the starting mark of a phrase or word and generally corresponds to silent pause of medium and short sentences. It reflects the transitory respiration of the speaker in the sentence.

Similar to basic types of inspiration curve, the position and verbal information of different types of expiration curves are also different. In general, sharp-drop curve usually appears at the end of the respiration group or the respiration segment and after the sentence or sub-sentence is finished. Since it is necessary to start to next sentence, the respiration at the boundary needs to end immediately so as to start a new round of respiration. In this way, sharp-drop curve shows the ending mark of a sentence or a sub-sentence. Slow-drop curve is the most common type in the expiration curve and generally shows in most exophasia process. Sometimes, when sharp-drop curve does not occur at the end of a sentence or a sub-sentence boundary, the whole sentence or the sub-sentence may show slow-drop curve. For flat-drop curve, it mostly appears in the middle or rear of a long sentence and is caused by respiration-holding. Flat-drop curve mostly corresponds to transitory stop in a long sentence, non-semantic focus word and function word. In some specific situations, it can play certain mark dividing role.

From the perspective of physiology, the expiration in verbal respiration is caused by elastic lung retraction. But in some cases, this is not enough for maintaining sub-glottal pressure. At this moment, inter-costal muscle group and abdominal muscle group will come alive so as to increase expiration force to maintain sub-glottal pressure [11]. This indicates that in order to produce specific sub-glottal pressure, the muscle group is required to change activity forms according to lung capacity. This will result in different respiratory units and different types of respiratory curves. The result exactly reflects people's expiratory adjustments physiologically according to different rhythms, semantics and other units.

Besides those characteristics of general respiratory curve during speech, the respiration of Chinese learners during self-narration shows some other features:

1) Expiratory curve is generally longer than the inspiration curve and the duration of expiration is many times of that of inspiration. Inspiration slope is generally higher than the corresponding expiration slope and is mostly more abrupt. Expiration slope has a big difference of slope. Inspiration process is mostly completed once. In the whole inspiration process, the slope remains basically consistent, but there is an exception. The slope during expiration changes according to the requirement of language expression. Therefore, the slope in expiration process is changing constantly.

2) There are great differences among peak values, valley values, peak value and valley value. Some large respiratory valleys often occur, which are often composed of an expiratory curve with large amplitude and high slope or the sharp drop part of an expiratory curve followed by an inspiratory curve with a large amplitude and high slope. Its existence increases the difference of peak and valley values in the whole respiratory process; therefore, it can increase the overall respiratory field. The respiratory amplitude has a large fluctuation. The amplitude of deep respiration can even be dozens of times of the shallow respiration.

3) Pauses in sentence accompanied by inspiratory process shows decrease. Pauses concentrate at the end of sentence or sub-clause in most case. Pauses between phrases and words

decrease significantly. Therefore, the respiratory curve has less small ups and downs and is relatively smooth.

4) Chinese learners of these four countries have filled words such as modal particle and pet phrase in the task of retelling, e.g. “um, ah, eh, hmm, this/that, later, that is to say and then”. Filled words have a few forms as follows: filled words + sentence/phrase/words (no pause after filled words; they occur in the same part of respiratory curve with sentence/phrase/words), filled words+pause, filled words+filled words etc. Such situation is especially obvious in American students and is a feature of respiration during speech of American overseas students during self-narration.

5) Long pauses occur, which will correspond to the corresponding respiratory curve. They mostly form an obvious respiratory curve and sometimes might occur in the same part of respiratory curve with other sentences.

6) Emotional characteristics sometimes occur with varied patterns of manifestation (e.g. laugh, speaking with laugh and sigh). Laugh is mostly corresponding to a large curve containing a few respiratory valleys, which often starts with sharp drop and ends with sharp ascent. The number and amplitude of respiratory valley is different in each situation. Speaking with laugh generally occur in sentences, which manifested as some small fluctuations in respiratory curve.

7) Some learners have “smack” in the process of self-narration. Such “smack” often occurs in inspiratory segment. In general, as self-narration is a more natural speech often accompanied by more mental activities, speech output habits and emotional expression, its respiratory curve has more complicated representations and therefore it is impossible to infer speech paragraph from respiratory curve.

IV. CHARACTERISTICS OF ABNORMAL PAUSE

In the experiment of the present study, subjects often have the following psychology during self-narration: There is no text for reference during self-introduction or insufficient time for preparation before self-narration and the content is completely decided by subjects themselves. Contents of their self-narration are very extensive, including their basic information, learning experience, hobbies and interests and family members. They have to organize the words and consider the content temporarily on site. This requires them to spend a lot of psychological resources controlling their language output. On the other hand, the experiment requires subjects introduce themselves under the most natural state. Subjects use verbal words and can include their personal emotions. In this way, subjects might control some monitoring on respiration due to the participation of psychological emotional factors. Therefore, their respiration during self-narration is flexible. Reasons above at the psychological level result in the following pause features during self-narration：

1) The times of pause increase. Under the task of self-narration, as the linguistic form is freer than loud reading and retelling, the relationship between the position of pause and prosodic boundary, grammar and semantics becomes more estranged. Therefore, pause during self-narration can break the limitation of rhythm and grammar and semantics and occur in any position.

2) Pause has various forms mostly with uncertain length and position and great individual variation, such as silent pause, zero pause, inadequate pause, overlong pause, addition of filled words and error in speaking; pauses caused by emotional characteristics such as laugh and smack; pauses caused by language habits such as pet phrase; and pauses caused by psychological factors.

3) Different pauses have different representations in respiratory curve. Pauses corresponding to inspiration curve include pause with sound, overlong pause, inadequate pause and pauses caused by filled words and smack; pauses that can correspond to expiration curve include pause with sound, overlong pause, zero pause, filled pause and pause caused by emotional features; some pauses can correspond to a complete respiratory curve such as overlong pause caused by thinking, pause caused by filled words and pause caused by “laugh”.

V. CONCLUSION AND DISCUSSION

This paper preliminarily analyzes the respiratory representation of Chinese learners, i.e., Korean, Japanese, American and Thai people, under the task of retelling. The result proposes that different respiratory units have significant differences in inspiration/expiration duration, amplitude and slope in terms of respiratory parameters. Differences of respiratory parameters can also reflect curve characteristics. Most respiratory curves tested have one or more obvious respiratory valleys; respiratory curves have less small ups and downs and are relatively smooth; modal particle and pet phrase correspond to the corresponding respiratory curve; in addition, emotional characteristics (laugh, sigh and smack) produce more small fluctuations and large respiratory valleys. Finally, abnormal pause has varied frequency of occurrence, type and corresponding curve and its length and position are uncertain. The occurrence of abnormal pause mostly comes from interruption of normal respiration and the deeper reason comes from cognitive psychology. Therefore, future researches on cognitive psychology level and emotional expression will be helpful for deepening the understanding of respiration during speech.

VI. ACKNOWLEGMENTS

This research was supported by the Youth Project “Research on the prosodic features and phonological expression of Chinese text” (10CYY036) of National Social Science Foundation China, and is supported by National Program on Key Basic Research Project (973 Program) of 2013CB329301, as well as the Innovation Program of Chinese Academy of Social Sciences “The acquisition and cognition of spontaneous speech”.

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[This paper was published in O-COCOSDA, 2013]