Taiwan Journal of Linguistics
Vol. 3.1, 101-132, 2005
doi:10.6519/TJL.2005.3(1).4

BREATH-GROUP THEORY VS. DECLINATION THEORY: EVIDENCE FROM CHINESE APHASICS*

Wen-Hui Sah

ABSTRACT

This study explores in what way the breath-group theory and the declination theory manifest themselves in Chinese aphasic speech and detects the extent to which aphasics exert control over sentential F_0 contours concerning different sentence lengths and tones. Four Broca's aphasics, four Wernicke's aphasics and four age-matched normal controls are tested. The results indicate that aphasic subjects have impairments in processing these sentential F_0 patterns. Yet, neither the declination nor the breath-group pattern can serve as the criterion in differentiating these two aphasic populations. The breath-group pattern is the better option than the declination pattern in delineating sentential F_0 contour in Mandarin Chinese speech, from which we note that the predictive power of the declination theory deserves reconsideration.

1. INTRODUCTION

Lieberman (1967) associates speech with respiration by stating that speech is planned in terms of the expiratory airflow from the lungs. He regards the "breath-group" as the basic unit for intonation and points out its chief function in segmenting speech signals into chunks. He also

* I am grateful to the anonymous reviewers for their valuable comments, which led to improvement of this paper. All gaps, mistakes and misunderstandings are my own responsibility.

makes a distinction between the unmarked breath-group pattern and the marked one.[1] At the end of each unmarked breath-group, the fundamental frequency (hereafter as F_0) will fall along with the decreasing pulmonary air pressure if the laryngeal tension is not deliberately increased.[2] According to Lieberman, the archetypal normal, or unmarked, breath-group is characterized by the terminal F_0 fall rather than the prosodic pattern before the terminal point. As he states (p. 26):

> It is a universal of human speech that, except for certain predictable cases, the fundamental frequency of phonation and the acoustic amplitude fall at the end of a sentence.

Lieberman and Blumstein (1988) state that most unemphatic, declarative sentences are produced by means of the unmarked pattern for its minimal muscular effort. In contrast, the “marked” pattern will be formed if the tension of the laryngeal muscles is increased at the end of the sentence with the pulmonary air pressure decreasing as usual. This pattern is the phonetic output of the normal yes-no question and that of the non-terminal breath-group of a long declarative sentence.[3]

Several later studies take the position different from that of the breath-group theory (Maeda, 1976; Liberman and Pierrehumbert, 1984; Sorensen and Cooper, 1980; Thorsen, 1986). These studies propose that the declination pattern characterized by linear decrease in pitch throughout the course of a declarative utterance is a near-universal tendency of intonation. In an earlier perceptual study by Cohen and 'T Hart (1967), a “declination line” is presented to characterize Dutch intonation. Similarly, Maeda (1976) uses the “trapezoidal shape” of localized movements superposing on the gradual falling “baseline” to describe the intonation of English declarative sentences.[4] He proposes

---

[1] The notations *–breath-group* and *+breath-group* are used to represent the unmarked pattern and the marked one, respectively.

[2] The studies on language development and infants' initial vocalizations lead Lieberman to conclude that the terminal F_0 fall of the breath-group is innately determined and that children may acquire the idiosyncratic pattern of the breath-group of their mother tongue during the first year of life (Lieberman, 1967).

[3] Due to physiological constraints, a longer sentence is often divided into more than one breath-group. The non-terminal breath-group uses non-falling F_0 contour of the marked pattern to signal continuation.

[4] The baseline refers to the line connecting all the F_0 valleys of a sentence.

five attributes and several rules to represent F_0 contours and conducts perceptual experiments to test the validity of the schematized F_0 patterns.[5] According to him, the magnitude of F_0 falling as well as the F_0 value at the terminal point of the breath-group is roughly constant for an individual speaker. Maeda notes that the terminal F_0 fall is primarily determined by the shortening of the vocal-fold length subsequent to the decrease in lung volume, whereas the subglottal air pressure is only partially responsible for the F_0 fall.

In contrast to Maeda's baseline, the Pierrehumbert and Liberman version of the declination theory proposes the topline (Pierrehumbert, 1977, 1979, Liberman and Pierrehumbert, 1984).[6] They claim that both topline and baseline display the declination effect, and that the former declines at a more rapid rate than the latter. Sorensen and Cooper (1980) assert that the topline is the better choice in capturing the essence of F_0 declination. In a later study, they formulate the topline rule and test the validity of it in predicting declination (Cooper and Sorensen, 1981). They claim that the magnitude of F_0 fall is proportional to the length of the entire sentence and that the higher F_0 value for the first peak accompanies the longer sentence (i.e., the P1 effect).[7] Moreover, they use the floor effect to explain the small deviation of the terminal F_0 value. Similarly, Thorsen (1986) observes the positive correlation between sentence length and the magnitude of F_0 fall. Yet, he questions the validity of the floor effect.

While the declination theory strictly defines a gradual fall in F_0 throughout a declarative sentence, the breath-group theory specifies only the terminal F_0 fall without characterizing the exact prosodic pattern before the terminal fall. As Tseng (1990) points out, the declination theory can be regarded as a special case of the breath-group theory. In contrast to the near-universal claim of the former, the latter offers no

---

[5] These five attributes are *baseline*, *rise*, *lowering*, *peak*, and *rise on the plateau*.

[6] The topline refers to the line connecting all F_0 peaks of a sentence.

[7] P1 stands for the first F_0 peak of a sentence. The P1 effect refers to the higher F_0 values of the first peak in the longer sentence compared with that in the shorter sentence. For instance, comparing the P1 F_0 value of two sentences, we find this effect for the normal speaker, with P1 F_0 value several hertz greater in the longer sentence than in the shorter sentence. The differences in P1 F_0 values in the long versus short utterances demonstrate normal speakers' look-ahead mechanism which programs the P1 F_0 value by taking into consideration the overall length of the upcoming utterance (Cooper and Paccia-Cooper, 1980, Cooper and Sorensen, 1981).

claims of universality. Thus, the breath-group theory is less powerful in making prediction, yet it can more flexibly characterize the possible intonation contours for simple declarative sentences.[8]

To test if the above-mentioned theories properly represent the intonation pattern for simple declarative Mandarin sentences, Tseng (1990) analyzes the overall intonation contours of spontaneous speech of two female Mandarin speakers. According to her, the declination pattern only captures the essence of a very small portion (20 %) of the data, whereas 74 % of the data can be characterized by the breath-group pattern. Accordingly, the predictability of the declination theory is questioned. In consonance with Tseng, Liu (1990) claims that the breath-group pattern can more properly describe the intonation contours of read speech than the declination pattern.[9] Moreover, 86% of her data exhibit the lowest valley F_0 value at the final target-word, whereas merely 69 % of the data demonstrate the lowest peak F_0 value at the final target-word. Thus, Liu suggests that the primary feature of the breath-group in Mandarin Chinese speech is the lowering of the valley F_0 value of the terminal word and asserts that the baseline rather than the topline can better characterize the declination pattern in Mandarin speech. Liu's subject shows no correlation between the magnitude of the F_0 lowering and sentence length, but exhibits negative correlation between the magnitude of F_0 lowering and the complexity of the sentence structure.[10]

Maeda (1976) uses the floor effect to explain that the sentence-final valley F_0 value is a relatively invariant characteristic of a speaker's voice. Similarly, Liberman and Pierrehumbert (1984) state that the sentence-final low point F_0 values in both of their experiments are essentially the same. They note that the final low value is rather constant for each individual speaker. However, in Liu's research, the speech output of the male Mandarin speaker does not exhibit the floor effect,

---

[8] According to Umeda (1981, 1982), the declination pattern has a discourse function. A speaker may use the declination intonation pattern to introduce a new topic for a discourse. However, during the course of the discourse, the archetypal breath-group pattern is used. The difference in discourse functions carried by these two intonation patterns is another interesting topic. Yet, it is beyond the scope of the present study.

[9] The term "read speech" is used by Lieberman et al. (1985) to refer to the prepared speech or the reading mode of speech.

[10] The negative correlation: The simpler the sentence structure is, the greater magnitude at which the F_0 falls.

since both the peak and valley F_0 values of the terminal word vary across a large range.

Within the last few decades, the intact and disordered elements of prosody have become increasingly useful media for making inferences about language representation and speech planning (Danly and Shapiro, 1982; Shapiro and Nagel, 1995; Blonder et al., 1995; Baum et al., 1997; Gandour and Dardarananda, 1984; Gandour and Petty, 1989; Gandour et al.; 1994, Schirmer et al.; 2001, Kimelman, 1999; Vijayan, 1998). The presence or absence of F_0 declination in aphasics allows us to assess patients' ability in programming sentential F_0 patterns. From three experiments using Broca's and normal subjects, Danly and Shapiro (1982) detect that patients' F_0 declination is present in short and simple sentences but does not occur over longer domains and that patients do not exhibit the P1 effect. They suggest that the declination might be attenuated by the extreme length of time that patients require to produce the sentences. Furthermore, they present a significant correlation between the declination slope and the degree of language disorder in Broca's aphasics; that is, the presence or absence of the downdrift reflects the severity of aphasia. On the other hand, Cooper, Danly and Hamby (1979) detect that Wernicke's speakers exhibit F_0 declination, though the obtained slope does not adhere to the topline rule precisely. There is no interaction between literal paraphasia and F_0 declination, which indicates that declination planning is independent of proper phoneme selection. In a later study, Danly, Cooper and Shapiro (1983) demonstrate that F_0 declination of Wernicke's aphasics is comparable to that of normal controls (except in the severest cases), and shows no interaction with verbal paraphasia or degree of impairment. According to them, Wernicke's aphasics are able to take into consideration the sentence length and declination slope to produce an initially higher F_0 value for longer sentences than for shorter ones.

In an earlier study, Sah (2004) explore the sentence-final peak-to-valley (hereafter as P-V) F_0 fall and the P1 effect in Chinese aphasic speech. Previous studies on English aphasics claim that the sentence-final P-V F_0 fall is the largest fall in magnitude. Surprisingly, Sah's work shows that the terminal P-V F_0 fall is not the largest F_0 fall for Mandarin Chinese speakers, normal or aphasic. The discrepancy between Chinese and English speakers concerning the largest terminal P-V F_0 fall is attributed to the difference in sentence lengths used in different studies. The analysis regarding the P1 effect aims to examine

whether the aphasic subjects can encode sentence length by appropriately planning the initial F_0 value. The results indicate that Broca's aphasics are impaired in programming this prosodic feature. In contrast, Wernicke's patients remain intact in this ability, which means that they are able to combine the factors of sentence length and F_0 contour in order to produce higher values of P1 for longer sentences. The issue closely relates to the sentence-final P-V F_0 fall and the P1 effect is the applicability of the breath-group theory and that of the declination theory.

Previous studies have explored the breath-group and the declination patterns for simple declarative Mandarin sentences from normal speakers. The present work differs from earlier investigations in including not only normal but also aphasic speakers in our subject pool. Despite widespread interest in the prosodic disturbances in aphasic patients, we lack information on how the breath-group and the declination patterns manifest themselves in aphasic speech. To fill a gap that currently exists in this respect, we aim to examine whether these F_0 patterns properly represent the intonation contours for simple declarative sentences from Mandarin Chinese speakers, normal and/or aphasic.

2. METHODS

The acoustic methodology reveals things about aphasics' internal code more directly than perceptual judgements (Cooper and Paccia-Cooper, 1980; Ryalls, 1982; Cruttenden, 1986; Baum and Boyczuk, 1999); therefore, the present study adopts the acoustic method to obtain a more objective assessment of the planning of sentential F_0 contours in Chinese aphasic speech.

We use the breath-group and the declination patterns as the criteria to examine aphasic patients' F_0 contours for simple declarative sentences.[11] Two research questions will be addressed:

[11] Since the previous studies mentioned above and the present work all focus on simple declarative sentences, only the unmarked breath-group intonation pattern is considered and explored in the following discussion. The marked pattern is beyond the scope of the present investigation.

(1) How do the breath-group and the declination patterns manifest themselves in Chinese aphasic speech?
(2) To what extent do aphasics exert control over sentential F_0 contours concerning different sentence lengths and tones?

2.1 Subjects

Eight aphasics and four age-matched normal controls serve as subjects in the experiment. All subjects are male and predominantly right-handed. The patient group comprises four Broca's and four Wernicke's aphasics; all of them suffer unilateral left-hemisphere damage subsequent to cerebral vascular disease or brain trauma, and have neither auditory nor visual disturbance. The diagnosis of aphasia is based upon a Chinese adaptation of the BDAE; the sites of lesions are determined by neurologists and corroborated by Computerized Tomography (CT) scan. The aphasic subjects are tested at least three months post onset. The normal controls roughly match in age and educational level to the aphasic subjects. All subjects are native speakers of Mandarin Chinese. Their personal background and medical data are illustrated in Table 1 (for Tables, see Appendix A).

2.2 Stimuli

Four groups, each with eight sentences, are constructed to test the subjects. Each group comprises four pairs; the target words in each pair represent one distinct Mandarin tone. Sentences range in length from six to fourteen syllables (Appendix B). The target words are the second syllable of disyllabic words which are all content words of high frequency.[12] One sample set appears below with the target words in parentheses. Filler sentences that match with the real target sentences in terms of length, phonetic environment and syntactic structure are used as the first and the last sentences of each recording session to minimize initiation and completion effects.

Ala　　小(柯)想去逛(街)

[12] As previous studies demonstrate, there are more phonological errors on content words than on function words and the speech production of Broca's aphasics is predominantly full of content words and often omits function ones (Blumstein, 1973).

Bla 小(柯)想跟小(湯)去逛(街)
Cla 小(柯)想跟小(湯)去東(區)逛(街)
Dla 小(柯)想跟台(玻)的小(湯)去東(區)逛(街)

2.3 Procedures

The test sentences are randomized across the subjects. An interval of approximately three seconds exists between the presentation of each sentence. The subjects were asked to read the test materials as naturally as possible and not to place contrastive or emphatic stress on any word. Before recording, the sentence was presented to the subject who was asked to read it aloud to ensure that he recognized the words and to practice it several times until at least one clearly articulated version of the completed sentence was produced.[13] The whole process of performing the task was audio-taped.

2.4 Data measurement and analysis

For each target-word, we use Visi-Pitch to measure the F_0 values of the tone-bearing unit at the peak and the valley. Two sentential F_0 contour patterns are examined: the breath-group and the declination patterns. For ease of comparison with the results from previous studies, we set up four categories based on Liu's definitions (1990) for these F_0 patterns, as stated below.

Category I: If the peak F_0 value of the terminal word is the lowest compared to the peak value(s) of the preceding target-word (s), the sentence is called the ***breath-group*** sentence.

Category II: If the valley F_0 value of the terminal word is the lowest compared to the valley value(s) of the preceding target-word(s), the sentence is classified as the ***breath-group*** sentence.

Category III: If the line connecting the F_0 peaks of all target

[13] The Broca's aphasic HT could not read sentences D2b and D4b on his own, so he was asked to repeat after the experimenter. He did not present any difficulty in repeating. Among the data collected, only these two are the repeated sentences. Owing to the scarcity of the repeated sentences, the possible practice effects of the repeated sentences are not considered here.

words, i.e., the ***topline***, decreases throughout the sentence, the sentence belongs to the ***declination*** group.

Category IV: If the line connecting the F_0 valleys of all target words, i.e., the ***baseline***, decreases from the beginning to the end of the sentence, the sentence is considered to be the ***declination*** sentence.

The F_0 contour patterns serve as dependent variables, while independent variables include both linguistic and non-linguistic factors: subject group (normal vs. aphasic speakers), sentence length (sentences of various lengths) and tone (four tones of Mandarin Chinese). Because the effects investigated in this study are analyzed in terms of frequency of occurrence, viz., on an all-or-none, discrete scale, we use overall and individual log-linear tests and the supplementary proportional z-test to assess the data. For the log-linear test, the probability (p) value has to be smaller than 0.05 to reach the significant level, while the z-score has to be larger than 1.96 to reach significance.

3. RESULTS AND DISCUSSION

Lieberman (1967) suggests that the breath-group pattern can properly represent the intonation contour for simple declarative sentences, while others believe that the declination pattern is a better candidate. In terms of the above-mentioned four categories, we first present the frequency distribution of sentences that can be characterized by the breath-group or the declination pattern, discuss subject group, sentence length and tone main effect on the distribution of these two intonation patterns (Section 3.1) and then assess which pattern most properly delineates the intonation contours for simple declarative Mandarin sentences (Section 3.2).

3.1 Frequency distribution of breath-group and declination patterns

There are 201 of the total 360 sentences classified into Category I (55.83 %). On the other hand, 217 of total utterances fall into Category II (60.28 %), with the frequency percentage larger than that of the former group. Tables 2 through 9 display the frequency distributions of Category I and II for individual independent variables and for

cross-sections of all these variables.

For sentences of Category I, we note that occurrence rate for normals (44.78 %) is obviously larger than that for Broca's (26.87 %) and for Wernicke's (28.36 %) subjects. The frequency difference between two-target- word sentences and sentences of other lengths also deserves attention. The results of the individual test of the log-linear analysis demonstrate significantly larger occurrence rate for two-target-word than for five-target-word sentences (χ^2_4 = 10.44, p = .001), but fail to demonstrate significant differences among subject groups, among tones or significant interactions among variables. By means of supplementary proportional z-test, we find significant differences between normals and Broca's aphasics (z = 3.73) and between normals and Wernicke's subjects (z = 3.30), but nonsignificant difference between Wernicke's and Broca's aphasics (z = .33). As for the sentence length, there are significant differences between two- and three- (z = 2.57), between two- and four- (z = 3.61), and between two- and five-target-word (z = 3.99) sentences.

Regarding sentences of Category II, the occurrence rate for normals (45.62 %) is obviously larger than that for Broca's (26.27 %) and Wernicke's (28.11 %) aphasics. The overall test of the log-linear analysis also exhibits significant subject main effect (χ^2_2 = 13.60, p = .001). Nevertheless, due to the insensitivity of the test to the limited data, the individual test fails to further display significant frequency differences among subject groups, among sentence-lengths, or among tones. As in the above case, the z-scores present significant differences between normal and Broca's subjects (z= 4.2) and between normal and Wernicke's subjects (z = 3.78), but nonsignificant difference between Broca's and Wernicke's subjects (z = .43). The significant frequency differences are also established between two- and four- (z = 3.17) and between two- and five-target-word (z =2.32) sentences.

The criteria for Category III and IV characterize the declination patterns. There are 133 of the total 360 utterances (36.94 %) exhibiting the topline effect (Category III), whereas 143 of the total utterances (39.72 %) demonstrate the baseline effect (Category IV). Tables 10 through 17 demonstrate the frequency distribution of Categories III and IV for individual major variables and for cross-sections of all three variables.

With respect to Category III, normals (51.13 %) exhibit larger frequency of the topline effect than Broca's (21.05 %) and Wernicke's (27.82 %) aphasics; the two-target-word sentences (52.63 %) reveal

obviously larger frequency than sentences of other lengths (Table 10). By means of the overall test of the log-linear analysis, significant subject main effect (χ^2_2= 9.01, p =.011) and sentence length main effect (χ^2_3= 23.11, p =.000) are obtained, whereas neither tone main effect (p =.860) nor any interaction among variables is revealed. Due to its insensitivity to the limited data, the individual log-linear test fails to reveal significant differences between Broca's and normal subjects (p = .232), between Wernicke's and normal subjects (p = .325), or among various sentence lengths. Again, the supplementary proportional z-test is used as an alternative to assess the data. The resulting z-scores reveal significant frequency differences between normal and Broca's subjects (z=5.12), between normal and Wernicke's subjects (z = 3.90), and between two- and three- (z =5.21), between two- and four- (z = 7.17) and between two- and five-target-word (z = 7.87) sentences, which confirm the tendency shown above in percentages.

As illustrated in Table 14, normals (50.35 %) demonstrate larger frequency of the baseline effect than Broca's (24.48 %) and Wernicke's (25.17 %) aphasics; the frequency of two-target-word (48.25%) sentences is conspicuously larger than that of other sentence lengths. The results of the overall test of the log-linear analysis present subject main effect (χ^2_2 = 10.77, p =.005) and sentence length main effect (χ^2_3= 26.54, p = .000), while neither tone main effect (p= .428) nor any significant interaction among variables is displayed. The individual test further indicates that the frequency of the baseline effect for two-target-word sentences is significantly larger than that for five-target-word sentences (χ^2_4 = 23.96, p = .000); however, this test fails to exhibit significant frequency differences between Broca's and normal subjects (p = .255), between Wernicke's and normal subjects (p= .301) and among other length-pairs. On the other hand, the supplementary proportional z-test reveals significant frequency differences between normal and Broca's subjects (z = 4.5) and between normal and Wernicke's subjects (z = 4.39), but nonsignificant difference between Wernicke's and Broca's subjects (z = .13). According to z-scores, the occurrence rate of the baseline effect for the two-target-word sentences is significantly larger than that for three- (z = 3.57), for four- (z = 6.71), and for five-target-word
(z = 8.86) sentences.

As indicated in statistics and larger percentage of frequencies in preceding paragraphs, normals exhibit more pronounced than aphasic

speakers the tendency of employing declination and breath-group patterns as the general feature in programming intonation contours for simple declarative sentences of Mandarin Chinese. On the other hand, aphasic speakers are impaired in this regard as reflected by the significant differences between normals and aphasics, both in percentages and in z- scores. Nevertheless, the frequency differences between Broca's and Wernicke's subjects concerning both patterns do not reach significance, which implies that neither the declination nor the breath-group pattern can serve as a criterion in differentiating these two aphasic populations.

Clinically, Broca's and Wernicke's speakers are contrasted in terms of their control of melodic line over an entire sentence. Broca's aphasics are characterized by dysprosody, while Wernicke's patients are considered to have normal prosody. Yet, our aphasic groups fail to display significant differences in prosodic control over the breath-group or the declination pattern, which leads us to question the validity of differentiating Broca's from Wernicke's aphasia in terms of "prosody." The discrepancy between clinical classification and our findings may be attributed to the heterogeneity of prosody. It is also the task of the present work to show how acoustic study might clarify the notion about prosody in clinical application.

The statistics for all four categories show that tones fail to exert significant influence on the frequency distribution of both intonation patterns. Regarding sentence lengths, there is significant distributional difference in these F_0 contours between sentences of two-target-words and those of other lengths. Inspection of data shows that the length effect mainly comes from the aphasic group, which reflects the negative correlation between F_0 programming and sentence length. The negative correlation between the increase in the sentence length and the decrease in the occurrence rate of both intonation patterns implies that it is more difficult for the aphasics to produce these F_0 contours in longer sentences (Tables 3, 7, 11, and 15).

The length effect shown above is consonant with the earlier finding by Danly and Shapiro (1982), which states that Broca's patients' F_0 declination is present in short and simple sentences but absent in longer ones. Previous studies on English aphasics also claim that Wernicke's aphasics exhibit F_0 declination comparable to normal speakers (Cooper, Danly and Hamby, 1979; Danly, Cooper and Shapiro, 1983). Surprisingly, our results show that Chinese Wernicke's aphasics are

impaired in processing F_0 contours. The discrepancy between Chinese and English Wernicke's subjects concerning the F_0 contours can be attributed to the difference in sentence lengths used in different studies. The test sentences in studies on English speakers are restricted to five-syllable sentences containing two target words. In contrast, the test sentences used in the present work are comparatively longer, ranging from six to fourteen syllables and containing more target words. Logically speaking, the shorter the sentences are, the more easily the speakers can process the sentential F_0 contours. To verify Wernicke's aphasics' ability in this regard, future research needs to employ longer test sentences for English Wernicke's aphasics and to collect more data from Chinese Wernicke's patients. Despite such a discrepancy, both declination and breath-group patterns do exist in Chinese aphasic speech, but aphasics have difficulties in planning F_0 contours over relatively long stretches of speech.

3.2 Breath-group or declination pattern for simple declarative Mandarin sentences

In the following discussion, we focus on the frequency distribution of the declination and the breath-group patterns within each subject group to assess which pattern is used more often in simple declarative Mandarin sentences.[14] In accordance with the findings in the previous section, normals reveal more robust the tendency in using these two intonation patterns (including all four categories) than aphasic speakers (Table 18). Except for the frequency of Category III (28.91 %) being slightly larger than that of Category IV (28.13 %) in Wernicke's speech, the numbers in other columns, with respect to each subject group, reveal that Category II exhibits larger frequency than Category I (54.80% vs. 51.92%; 47.66 vs. 44.53%; 77.34% vs. 70.31), and that Category IV shows larger frequency than Category III (33.65% vs. 26.92%; 56.25% vs. 53.13%). In addition, for each subject group, the frequencies of Category I and Category II are obviously larger than those of Category III and Category IV. The total amount of occurrence rate with regard to each F_0 pattern displays the same trend (i.e., 55.83 % and 60.28 % are larger than 36.94 % and 39.72 %).

[14] The percentages are computed by dividing the number of sentences demonstrating each pattern by the total number of sentences from each subject group.

Moreover, there are 48.33 % of total utterances that meet the criteria for both Category I and II, whereas only 30 % for both Category III and IV. Therefore, it seems feasible for us to suggest that Chinese speakers, whether normals or aphasics, use both breath-group and declination patterns as organizing principles in programming intonation contours, and that they tend to produce the former pattern more often than the latter one. As indicated, the valley F_0 value of the terminal word (Category II) and the baseline (Category IV) can better capture the essence of the breath-group and the declination patterns than their counterparts, respectively, and the frequency difference between these two features (60.28 % vs. 39.72 %) is significant ($z = 5.52$), which again suggests that the breath-group pattern is more pronounced than the declination pattern in Mandarin Chinese speech.

For ease of comparison, results of the present study and those of two previous research (Tseng, 1990; Liu, 1990) on the breath-group and the declination theories are listed in Table 19.[15] Whether for normals or aphasics, our data suggest that the breath-group is the better alternative in characterizing intonation pattern for simple declarative Mandarin sentences, which supports Tseng's and Liu's findings. As stated earlier, the declination pattern is more strictly defined and is thus considered to be a special case of the breath-group pattern. Accordingly, all the sentences displaying the declination pattern can also be delineated by the breath-group pattern, which leads to the superiority of the breath-group pattern over the declination pattern in characterizing intonation contours for declarative sentences. As Tseng claims, the declination pattern does exhibit in Chinese speech, but its occurrence rate is significantly lower than that of the breath-group pattern. Likewise, studies on the intonation of American English, British English and Mandarin Chinese fail to locate the declination pattern in many utterances (Lieberman and Blumstein, 1988). Therefore, we conclude that the predictive power of the declination theory with respect to F_0 planning is not as strong as claimed by its proponents.

With regard to normal subjects, the frequencies for both intonation patterns in Tseng's, Liu's and the present studies indicate that both patterns are more pronounced in read speech than in spontaneous speech

---

[15] Since Category II and Category IV can better characterize the breath-group and the declination patterns respectively, we compare the frequency distribution of these two features, instead of four, of Liu’s and our studies.

(73 % or 56 vs. 20 % for declination pattern; 86 % or 77 % vs. 74 % for breath-group pattern), which supports the claim of Lieberman et al. (1985). As Liu elucidates, these intonation patterns tend to occur in read speech more often, because speakers know where the utterance will end and it is easier for them to plan ahead the intonation pattern. In spontaneous speech, the context will exert great influence on intonation pattern of the target sentence and thus mask the pattern that shown. If we focus on occurrence rate for all subjects of the present study, including both normal and aphasic speakers, we will find that, as expected, the declination pattern is also more pronounced in read speech than in spontaneous speech (40 % vs. 20 %). For the breath-group pattern, Liu's study displays similar superiority of read speech over spontaneous speech (86% vs. 74%). However, the reverse tendency is detected in our study, in which the breath-group pattern is more pronounced in spontaneous speech than in read speech (74% vs. 60%). We are uncertain whether this deviant tendency shown in our data is attributed to the disturbances in aphasic speech or to the different subject categories involved in these studies.[16] Before any conclusion is reached, more empirical data is needed to provide a clearer picture about this issue. Nevertheless, it is hoped that such a discrepancy will have implications for studies on F_0 contours concerning different speech mode.

5. CONCLUDING REMARKS

Using sentence reading task, we assess in what way the breath-group and the declination patterns manifest themselves in Chinese normal and aphasic speech. The data presented in earlier discussions inform us the following points.

(1) Aphasic subjects do not exhibit so robust the tendency as normals in producing the breath-group and the declination patterns for simple declarative sentences. Compared with normals, aphasic speakers are impaired in this regard. Yet, neither the declination nor the breath-group pattern can serve as a criterion in differentiating these two

[16] Tseng uses two female native speakers of Mandarin Chinese; Liu applies her test to one male speaker. In the present work, our male subjects include eight aphasic and four normal speakers.

aphasic groups. In addition, aphasics show more difficulty in producing them for longer sentences. No tone effect is detected in the processing of these F_0 patterns.

(2) Both aphasic and normal Chinese speakers do employ both F_0 patterns in their speech, though the breath-group pattern is the better option in delineating sentential F_0 contour for simple declarative Mandarin sentences, from which we note that the predictive power of the declination theory deserves reconsideration, as suggested by Tseng (1990) and Liu (1990). According to Lieberman (1967), the terminal falling contour of the breath-group is innately determined; what is more, the breath-group helps to disambiguate sentences. It is thus assumed that the breath-group pattern has more advantages over the declination pattern in language processing, which leads to the more pronounced status of the former pattern in Chinese speech.

(3) Our results indicate that the baseline and the terminal valley F_0 value can better capture the essence of the declination and the breath-group phenomena, respectively. The superiority of the baseline over the topline in Liu's (1990) and our studies implies that the topline proposed by Sorensen and Cooper (1980) does not necessarily hold advantages over its counterpart in all languages.

(4) In consonance with the findings of Lieberman et al.(1985), the results from our normal subjects reveal that these two F_0 patterns are more pronounced in read than in spontaneous speech for the ease of preplanning in the former condition. As Cooper and Paccia-Cooper (1980) comment, the results from read speech is more indicative of the speaker's planning abilities than those from spontaneous conversation.

In a series of studies, we examined Chinese Broca's and Wernicke's aphasics' ability in sentence-final lengthening, the sentence-final peak-to-valley F_0 fall and the P1 effect (Sah 2001, 2004). In the present work, we note that both Broca's and Wernicke's aphasics have disturbances in processing F_0 contours.[17] Taken together, the findings show that our aphasic subjects demonstrate different behavior with respect to different prosodic features (Table 20). Clinically, Broca's and Wernicke's speakers are contrasted in terms of verbal fluency and the control of melodic line of an entire sentence. According to this view,

[17] The present study employs the same subjects and test materials as those used in earlier experiments.

speech prosody in Wernicke's aphsics is considered to remain intact, whereas Broca's aphasics are characterized by dysprosody (Hecaen and Albert, 1978). The information listed in Table 20 reminds us that the speech prosody of Wernicke's aphasics is not strictly normal. Although the intonational contour of Wernicke's aphasics sounds quite normal to the clinician, it may contain certain deficits, such as the abnormalities in F_0 contours, which may be imperceptible. The results also document an apparent dissociation of prosodic impairments.[18] The dissociable prosodic impairments suggest that "prosody" should be regarded as a heterogeneous collection. The problem with the clinical impression of dysprosody or normal prosody may be that the concept about prosody is used in a too general way. When we use prosody as the criterion for clinical assessment, we have to specify which prosodic feature is actually involved to make the classification or the comparison viable.

REFERENCES

Baum, Shari, and Jeffrey Boyczuk. 1999. Speech timing subsequent to brain damage: effects of utterance length and complexity. *Brain and Language* 67: 30-45.

---

[18] As Baum and Boyczuk (1999) mention, the dissociation of impairments can be interpreted in the context of the autosegmental theory, proposed by Goldsmith (1976, 1990). Adopting the multi-tier approach, Levelt (1989) proposes a possible architecture of speech production. He hypothesizes that there exist autonomous multi-tiers in charge of different prosodic features. Under this framework, the dissociation of prosodic deficits in aphasic speech is explicable, since various events (e.g., temporal control, the terminal P-V F_0 fall, the P1 effect, or sentential F_0 contours) may take place at the different tier without necessarily having any effect on what goes on at another tier. Thus, an aphasic speaker may remain intact in the tier which processes one prosodic feature (e.g., the sentence-final P-V F_0 fall), while he may have deficits in other tiers which program certain other features (e.g., the P1 effect or the sentential F_0 contour).

Though such interpretation seems rather plausible, we need more experiments to show that there is really a hierarchical relationship between these F_0 attributes, to show the difference among these tiers, and to show how these prosodic parameters are conceived as structural constructs in the competence model such as the autosegmental theory. These research questions are beyond the scope of the present work. Before any valid interpretation can be made, we need more investigations to further explore these issues.

Baum, Shari, and Marc Pell, Carol Leonard, and Jeanne Gordon. 1997. The ability of right- and left-hemisphere-damaged individuals to produce and interpret prosodic cues marking phrasal boundaries. *Language and Speech* 40: 313-330.

Blonder, Lee, John Pickering, Robin Heath, Charles Smith, and Steven Butler. 1995. Prosodic characteristics of speech pre- & post-right hemisphere stroke. *Brain and Language* 51: 318-335.

Blumstein, Sheila. 1973. *A Phonological Investigation of Aphasic Speech*. The Hague: Mouton.

Breckenridge, Janet. 1977. The declination effect. *Journal of the Acoustical Society of America* 61, S1, S90.

Cohen, A., and J. 'T Hart. 1967. On the anatomy of intonation. *Lingua* 19: 177-192.

Cooper, William, Martha Danly, and Suzanne Hamby. 1979. *Fundamental frequency (F_0) attributes in the speech of Wernicke's aphasics*. Paper Presented at the 97th Meeting of the Acoustical Society of America.

Cooper, William, and Jeanne Paccia-Cooper. 1980. *Syntax and Speech*. Cambridge, Mass.: Harvard University Press.

Cooper, William, and John Sorensen. 1981. *Fundamental Frequency in Sentence Production*. New York: Springer-Verlag.

Cruttenden, Alan. 986. *Intonation* (pp. 1-15). Cambridge: Cambridge University Press.

Danly, Martha, William Cooper, and Barbara Shapiro. 1983. Fundamental frequency, language processing, and linguistic structure in Wernicke's aphasia. *Brain and Language* 19: 1-24.

Danly, Martha, and Barbara Shapiro. 1982. Speech prosody in Broca's aphasia. *Brain and Language* 16: 171-190.

Gandour, Jack, Sumalee Dechongkit, Suvit Ponglorpisit, and Fuangfa Khunadorn. 1994. Speech timing at the sentence level in Thai after unilateral brain damage. *Brain and Language* 46: 419-438.

Gandour, Jack, and Rochana Dardarananda. 1984. Prosodic disturbance in aphasia: Vowel length in Thai. *Brain and Language* 23: 206-224.

Gandour, Jack, and Soranee Petty. 1989. Dysprosody in Broca's aphasia: A case study. *Brain and Language* 37: 232-257.

Goldsmith, John. 1976. An overview of autosegmental phonology. *Linguistic Analysis* 2.1: 23-68.

Goldsmith, John. 1990. *Autosegmental and Metrical Phonology*. Oxford: Blackwell.

Hecaen, Henri, and Martin Albert. 1978. *Human Neuropsychology*. New York: Wiley.

Kimelman, Mikael. 1999. Prosody, linguistic demands and auditory comprehension in aphasia. *Brain and Language* 69.2: 212-221.

Levelt, Willem. 1989. *Speaking from Intention to Articulation*. Cambridge, Mass.: MIT Press.

Lieberman, Philip. 1967. *Intonation, Perception and Language*. Cambridge, Mass.: MIT Press.

Liberman, Mark, and Janet Pierrehumbert. 1984. Intonational invariance under changes in pitch range and length. In M. Aronoff and R. Oehrle (eds), *Language Sound Structure: Studies in Phonology*, 157-233. Cambridge, Mass.: MIT Press.

Lieberman, Philip, and Sheila Blumstein. 1988. *Speech Physiology, Speech Perception, and Acoustic Phonetics*. Cambridge: Cambridge University Press.

Lieberman, Philip, William Katz, Allard Jongman, Roger Zimmerman, and Mark Miller. 1985. Measures of the sentence intonation of read and spontaneous speech in American English. *Journal of the Acoustical Society of America* 77: 649-657.

Liu, H. Y. 1990. An acoustic phonetic study on intonation in Mandarin Chinese. M.A. thesis. National Tsing Hua University.

Maeda, Shinji. 1976. *A Characterization of American English Intonation*. Cambridge: MIT dissertation.

Pierrehumbert (nee Breckenridge), Janet. 1979. The perception of fundamental frequency declination. *Journal of the Acoustical Society of America* 66: 363-369.

Ryalls, John. 1982. Intonation in Broca's aphasia. *Neuropsychologia* 20: 355-360.

Sorensen, John, and William Cooper. 1980. Syntactic coding of fundamental frequency in speech production. *Perception and Production of Fluent Speech*. Ed. R. A. Cole. Hillsdale, N.J.: Lawrence Erlbaum Associates. Pp. 399-440.

Sah, Wen-hui. 2001. Speech prosody in Chinese Broca's and Wernicke's aphasics: An acoustic investigation of word duration. Paper Presented at the 3rd Annual Meeting of the Speech-Language-Hearing Association. Taiwan: Taipei.

Sah, Wen-hui. 2004. The control of fundamental frequency in Chinese aphasics: Impaired or intact prosody. *Concentric: Studies in Linguistics* 30.1: 129-149.

Schirmer, Annett, Kai Alter, Sonja Kotz, and Angela Friederic. 2001. Lateralization of prosody during language production: A lesion study. *Brain and Language* 76.1: 1-17.

Shapiro, Lewis, and Nicholas Nagel. 1995. Lexical properties, prosody, and syntax: implications for normal and disordered language. *Brain and Language* 50.2: 240-257.

Thorsen, Nina-Gronnum. 1986. Sentence intonation in textual context -- Supplementary data. *Journal of the Acoustical Society of America* 80.4: 1041-1047.

Tseng, C. Y. 1990. *An Acoustic Phonetic Study on Tones in Mandarin Chinese. Special Publication No.94*. Taipei: Institute of History & Philology, Academia Sinica.

Umeda, Norihiro. 1981. F_0 rule for discourse. *Journal of the Acoustical Society of America* 69, S82.

Umeda, Norihiro 1982. F_0 declination in situation dependent. *Journal of Phonetics* 10: 279-290.

Vijayan, Aparna. 1998. *Speech Production after Unilateral Brain Damage: Aspects of Linguistic Prosody*. Purdue University dissertation.

Wen-hui Sah
Department of English
National Chengchi University
whsah@nccu.edu.tw

APPENDIX A

Table 1. Personal Data of Aphasic and Normal Subjects

Subject Category*	Name	Sex	Age yrs	Educ. yrs	Post Onset	Etiology	Lesion Site CT
B	TC	M	34	12	3;1	CVA	Frontal
B	CC	M	38	16	3;8	Trauma	frontal- temporal-parietal
B	HT	M	74	12	1;11	CVA	frontal
B	FL	M	75	19	0;4	CVA	frontal- temporal
W	SM	M	16	9	2;8	Trauma	frontal- temporal
W	LM	M	51	12	2;7	Trauma	temporal
W	MN	M	54	6	0;11	CVA	frontal
W	ML	M	58	16	1;10	CVA	frontal-parietal
Mean			50.00	12.75			
SD			18.83	3.90			
N	PC	M	75	9			
N	WM	M	56	12			
N	TL	M	38	12			
N	KP	M	24	17			
Mean			48.25	12.5			
SD			19.16	2.87			

- B=Broca's aphasics W=Wernicke's aphasics N=Normals

Table 2. Frequency Distribution of Sentences of Category I for Individual Major Categories (N = 201)

		Raw Frequency	Percentage
Subject Category	Broca's	54	26.87 %
	Wernicke's	57	28.36 %
	Normal	90	44.78 %
Sentence Length	Two	70	34.83 %
	Three	49	24.38 %
	Four	42	20.90 %
	Five	40	19.90 %
Tone	Tone 1	56	27.86 %
	Tone 2	48	23.88 %
	Tone 3	46	22.89 %
	Tone 4	51	25.37 %

Table 3. Frequency Distribution of Sentences of Category I for Different Subject Categories and Sentence Lengths (N=201)

Sentence length / Subject Category	Two	Three	Four	Five	Total (raw frequency)	Percentage (%)
Broca	24	9	10	11	54	26.87
Wernicke	20	17	10	10	57	28.36
Normal	26	23	22	19	90	44.78
otal (raw frequency)	70	49	42	40	201	
Percentage (%)	34.83	24.38	20.90	19.90		

Table 4. Frequency Distribution of Sentences of Category I for Different Subject Categories and Tones (N=201)

Tone / Subject Category	Tone 1	Tone 2	Tone 3	Tone 4	Total (raw frequency)	Percentage (%)
Broca	16	15	11	12	54	26.87
Wernicke	15	13	13	16	57	28.36
Normal	25	20	22	23	90	44.78
otal (raw frequency)	56	48	46	51	201	
Percentage (%)	27.86	23.88	22.89	25.37		

Table 5. Frequency Distribution of Sentences of Category I for Different Sentence Lengths and Tones (N=201)

Tone / Sentence Length	Tone 1	Tone 2	Tone 3	Tone 4	Total (raw frequency)	Percentage (%)
Two	20	19	15	16	70	34.83
Three	13	11	13	12	49	24.38
Four	12	9	10	11	42	20.90
Five	11	9	8	12	40	19.90
otal (raw frequency)	56	48	46	51	201	
Percentage (%)	27.86	23.88	22.89	25.37		

Table 6. Frequency Distribution of Sentences of Category II for Individual Major Categories (N =217)

		Raw Frequency	Percentage
Subject Category	Broca's	57	26.27 %
	Wernicke's	61	28.11 %
	Normal	99	45.62 %
Sentence Length	Two	69	31.80 %
	Three	53	24.42 %
	Four	44	20.28 %
	Five	51	23.50 %
Tone	Tone 1	61	28.11 %
	Tone 2	50	23.04 %
	Tone 3	55	25.35 %
	Tone 4	51	23.50 %

Table 7. Frequency Distribution of Sentences of Category II for Different Subject Categories and Sentence Lengths (N=217)

Sentence length / Subject Category	Two	Three	Four	Five	Total (raw frequency)	Percentage (%)
Broca	20	13	11	13	57	26.27
Wernicke	21	18	10	12	61	28.11
Normal	28	22	23	26	99	45.62
otal (raw frequency)	69	53	44	51	217	
Percentage (%)	31.80	24.42	20.28	23.50		

Table 8. Frequency Distribution of Sentences of Category II for Different Subject Categories and Tones (N=217)

Tone / Subject Category	Tone 1	Tone 2	Tone 3	Tone 4	Total (raw frequency)	Percentage (%)
Broca	18	13	14	12	57	26.27
Wernicke	17	13	16	15	61	28.11
Normal	26	24	25	24	99	45.62
otal (raw frequency)	61	50	55	51	217	
Percentage (%)	28.11	23.04	25.35	23.50		

Table 9. Frequency Distribution of Sentences of Category II for Different Sentence Lengths and Tones (N=217)

Tone / Sentence Length	Tone 1	Tone 2	Tone 3	Tone 4	Total (raw frequency)	Percentage (%)
Two	19	16	18	16	69	31.80
Three	14	11	13	15	53	24.42
Four	13	10	11	10	44	20.28
Five	15	13	13	10	51	23.50
otal (raw frequency)	61	50	55	51	217	
Percentage (%)	28.11	23.04	25.35	23.50		

Table 10. Frequency Distribution of Sentences of Category III for Individual Major Categories (Topline Effect) (N =133)

		Raw Frequency	Percentage
Subject Category	Broca's	28	21.05 %
	Wernicke's	37	27.82 %
	Normal	68	51.13 %
Sentence Length	Two	70	52.63 %
	Three	32	24.06 %
	Four	20	15.04 %
	Five	11	8.27 %
Tone	Tone 1	40	30.08 %
	Tone 2	31	23.31 %
	Tone 3	28	21.05 %
	Tone 4	34	25.56 %

Table 11. Frequency Distribution of Sentences of Category III for Different Subject Categories and Sentence Lengths (N=133)

Sentence length / Subject Category	Two	Three	Four	Five	Total (raw frequency)	Percentage (%)
Broca	21	6	1	0	28	21.05
Wernicke	24	8	4	1	37	27.82
Normal	25	18	15	10	68	51.13
otal (raw frequency)	70	32	20	11	133	
Percentage (%)	52.63	24.06	15.04	8.27		

Table 12. Frequency Distribution of Sentences of Category III for Different Subject Categories and Tones (N=133)

Tone / Subject Category	Tone 1	Tone 2	Tone 3	Tone 4	Total (raw frequency)	Percentage (%)
Broca	8	7	6	7	28	21.05
Wernicke	13	8	7	9	37	27.82
Normal	19	16	15	18	68	51.13
otal (raw frequency)	40	31	28	34	133	
Percentage (%)	30.08	23.31	21.05	25.56		

Table 13. Frequency Distribution of Sentences of Category III for Different Sentence Lengths and Tones (N=133)

Tone / Sentence Length	Tone 1	Tone 2	Tone 3	Tone 4	Total (raw frequency)	Percentage (%)
Two	21	18	15	16	70	52.63
Three	8	8	6	10	32	24.06
Four	7	3	5	5	20	15.04
Five	4	2	2	3	11	8.27
otal (raw frequency)	40	31	28	34	133	
Percentage (%)	30.08	23.31	21.05	25.56		

Table 14. Frequency Distribution of Sentences of Category IV for Individual Major Categories (Baseline Effect) (N = 143)

		Raw Frequency	Percentage
Subject Category	Broca's	35	24.48 %
	Wernicke's	36	25.17 %
	Normal	72	50.35 %
Sentence Length	Two	69	48.25 %
	Three	41	28.67 %
	Four	21	14.69 %
	Five	12	8.39 %
Tone	Tone 1	41	28.67 %
	Tone 2	36	25.17 %
	Tone 3	34	23.78 %
	Tone 4	32	22.38 %

Table 15. Frequency Distribution of Sentences of Category IV for Different Subject Categories and Sentence Lengths (N=143)

Sentence length / Subject Category	Two	Three	Four	Five	Total (raw frequency)	Percentage (%)
Broca	21	12	2	0	35	24.48
Wernicke	24	8	3	1	36	25.17
Normal	24	21	16	11	72	50.35
otal (raw frequency)	69	41	21	12	143	
Percentage (%)	48.25	28.67	14.69	8.39		

Table 16. Frequency Distribution of Sentences of Category IV for Different Subject Categories and Tones (N=143)

Tone / Subject Category	Tone 1	Tone 2	Tone 3	Tone 4	Total (raw frequency)	Percentage (%)
Broca	11	9	8	7	35	24.48
Wernicke	10	10	9	7	36	25.17
Normal	20	17	17	18	72	50.35
otal (raw frequency)	41	36	34	32	143	
Percentage (%)	28.67	25.17	23.78	22.38		

Table 17. Frequency Distribution of Sentences of Category IV for Different Sentence Lengths and Tones (N=143)

Tone / Sentence Length	Tone 1	Tone 2	Tone 3	Tone 4	Total (raw frequency)	Percentage (%)
Two	19	21	15	14	69	48.25
Three	11	7	13	10	41	28.67
Four	7	5	4	5	21	14.69
Five	4	3	2	3	12	8.39
otal (raw frequency)	41	36	34	32	143	
Percentage (%)	28.67	25.17	23.78	22.38		

Table 18. Frequency Distribution of Breath-group and Declination Patterns Within Each Subject Group and of Total Utterances (%)

	Breath-Group Pattern		Declination Pattern	
Category	I	II	III	IV
Broca's	51.92	54.80	26.92	33.65
Wernicke's	44.53	47.66	28.91	28.13
Normals	70.31	77.34	53.13	56.25
Total	55.83	60.28	36.94	39.72
	Category I & II		Category III & IV	
Total	48.33		30	

Table 19. Comparison Among the Results of Tseng's, Liu's and the Present Research (%)

	Tseng's (spontaneous)	Liu's (read)	Sah's (read)
Declination Pattern	20	73	56 (normal)* 40 (total)
Breath-Group Pattern	74	86	77 (normal) 60 (total)

*Normal refers to the occurrence rate for normal subjects in our study; total refers to the occurrence rate for all subjects, normals and aphasics, in the present study.

Table 20. Prosodic Performance of Aphasics*

Prosodic Features	Broca's	Wernicke's
Sentence-final Lengthening	impaired	impaired
Breath-group Pattern	impaired	impaired
Declination Pattern	impaired	impaired
Sentence-final P-V F_0 Fall	intact	intact
P1 Effect	impaired	intact

*The results are from two previous studies (Sah, 2001, 2004) and the present one.

APPENDIX B*

Filler Sentence:小曾想去買書

Group A: Two-Target-Word Sentences
A1a** 小(柯)想去逛(街)
A1b 小(高)想去野(餐)
A2a 小(彭)想去打(球)
A2b 小(田)想去旅(行)
A3a 小(管)想去游(泳)
A3b 小(許)想去慢(跑)
A4a 小(賴)想去吃(飯)
A4b 小(畢)想去散(步)

Group B: Three-Target-Word Sentence
B1a 小(柯)想跟小(湯)去逛(街)
B1b 小(高)想跟小(周)去野(餐)
B2a 小(彭)想跟小(程)去打(球)
B2b 小(田)想跟小(錢)去旅(行)
B3a 小(管)想跟小(郝)去游(泳)
B3b 小(許)想跟小(沈)去慢(跑)
B4a 小(賴)想跟小(戴)去吃(飯)
B4b 小(畢)想跟小(紀)去散(步)

Group C: Four-Target-Word Sentences
C1a 小(柯)想跟小(湯)去東(區)逛(街)
C1b 小(高)想跟小(周)去深(坑)野(餐)
C2a 小(彭)想跟小(程)去新(竹)打(球)
C2b 小(田)想跟小(錢)去溪(頭)旅(行)
C3a 小(管)想跟小(郝)去淡(水)游(泳)
C3b 小(許)想跟小(沈)去操(場)慢(跑)
C4a 小(賴)想跟小(戴)去木(柵)吃(飯)
C4b 小(畢)想跟小(紀)去學(校)散(步)

Group D: Five-Target-Word Sentences
D1a 小(柯)想跟台(玻)的小(湯)去東(區)逛(街)
D1b 小(高)想跟台(新)的小(周)去深(坑)野(餐)
D2a 小(彭)想跟台(航)的小(程)去新(竹)打(球)
D2b 小(田)想跟台(僑)的小(錢)去溪(頭)旅(行)
D3a 小(管)想跟台(北)的小(郝)去淡(水)游(泳)
D3b 小(許)想跟台(鐵)的小(沈)去操(場)慢(跑)
D4a 小(賴)想跟台(電)的小(戴)去木(柵)吃(飯)

D4b　　小(畢)想跟台(汽)的小(紀)去學(校)散(步)

Filler Sentence:小葉想跟台巨的小蔡去新店上課

*For ease of reference, we put the target words in parentheses in this appendix.
** “1”, “2”, “3”, and “4” stand for Tone 1, Tone 2, Tone 3, and Tone 4, respectively.

由漢語失語症病人敘述句的語調表現看
「呼吸群理論」及「傾斜理論」

薩文蕙
國立政治大學

本研究透過漢語失語症病人其簡單敘述句的語調基頻表現，來檢驗「呼吸群理論」及「傾斜理論」的描述適切性。本研究實驗組有八名失語症病人。根據波士頓失語診斷測驗，布氏病人共四位，維氏病人共四位。控制組為四位健康的正常人。實驗者設計了四組長度不同的句子；每組八句，每句之關鍵字為同一聲調，八句平均使用國語中四個聲調。受試者需將實驗者所呈現的的句子唸出，所有語料均錄音並進行聲學分析。最後，將分析結果加以統計考驗。實驗結果顯示，失語症病人的語調掌握能力受到損壞，但這兩種理論均無法作為區分布氏及維氏症人的依據。兩者相較，「呼吸群理論」較能捕捉漢語失語症病人及正常人敘述句的語調特性，而「傾斜論」的描述適切性也因此受到質疑。