Influence of Japanese Students' Shallow and Rapid Respiratory Rhythms on Their English Comprehension
—Characteristics of Students Grouped by TOEIC Score—

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Conference Key Areas: Language issues in engineering education, Internationalization, Lifelong learning

Keywords: Japanese, shallow and rapid, English, deep and prolonged, respiration

INTRODUCTION

A KOSEN, which is translated into a National College of Technology in English, is a school providing five-year engineering education from 15 years old. There are 51 of them in Japan now, and one of which, Hakodate National College of Technology was established in 1961, in response to a strong demand from the industrial sector to foster engineers who sustained the high Japanese economic growth at that time. Since then, English is a very important mandatory subject because one of the educational goals is to train global engineers. However, Japanese students more or less feel difficulty studying English. English expression requires stress and rhythm to accurately convey its meanings. On the other hand, Japanese is a mora language, mainly requiring pitches (Nakamori, 2010). For example, the Japanese pronounced word, [ni・ tsu・ po・ ng・ go], with five units, is comprehended as three syllables, [nip-pon-go] by a native English speaker (Torii & Kaneko, 1979). When learning a foreign language, many learners experience interference from their mother tongues. (Nariai & Tanaka, 2010). When the first author conducted an oral speed reading test to examine reading skills, several students ignored the sound chunks[*1)] when they read the text aloud. (See the examples below. [/] indicates a breath.)

Example1: Some / final instruction will be given then.
Example2: We will raise a lot of much-needed funds for the / bands, the drama club, and our sports teams.

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A hunchbacked position[*3)] was a commonly observed feature among those students while reading. According to them, they took breaths at the [/] marks because they felt like they were suffocating. From hearing the students, the first author arrived at the assumption that the students prioritize either the rhythm of their native Japanese or their ordinary breathing rhythms when reading and listening to English. According to Chafe (1988), a writer writes using the phonemes of his/her “inner voice” to express a personal auditory image employing rhythm and tone of voice. On this basis, it can be assumed that the reader approaches writing using his or her inner voice to understand the writer’s meaning. Denny (2000) explains that a control mechanism to regulate inspiratory volume during quiet breathing also influences breathing during speech. In addition, Nakamura (2009) shows that pauses while speaking in the Japanese language are noticeably longer than in English. If our students apply the shallow and rapid breathing rhythms to their own inner voice while listening to and reading English, their inner voice will not be able to fully process English, because of its deep and prolonged breathing rhythms. This situation might cause unnatural pauses in English sentences like those seen in the above examples. Therefore, the authors established the hypothesis that Japanese students, with shallow and rapid respiratory rhythms caused by their hunchbacked position, cannot effectively listen to or read English, because it is pronounced with deep and long respiratory rhythms. In investigating this hypothesis, we also investigated the experimental procedures used in previous pilot studies[4)5)]. In this paper, we investigated whether there is a relationship between students’ TOEIC listening and reading scores, posture, and respiratory function. Each of our student recruits took part in an individual listening experiment and reading experiment and had his/her peak airflow rate measured. We grouped individual data into three groups—upper, middle, and lower—based on their TOEIC scores, and examined whether there are any commonly observed remarkable features either within a group or among the groups.

1 SUBJECTS

We recruited 14 student volunteers who had taken TOEIC IP test on June 6, 2012. The subjects were 4 females and 10 males, with an average age of 20.4 years. They were all in good physical health. The experiments were sanitary and protected the confidentiality of subjects’ personal information. Table 1 shows the TOEIC scores of the subjects in this study.

Table 1 Subjects’ TOEIC Scores

Subject	Age	Sex	Listening Score	Reading Score	Total Score
R1	20	M	295	285	580
R2	19	M	345	260	605
R3	4	F	360	265	625
R4	5	M	315	275	590
R5	4	F	235	165	400
R6	21	M	195	165	360
R7	21	M	260	130	390
R8	21	M	190	205	395
R9	21	M	265	165	430
R10	21	M	235	205	440
R11	21	F	265	175	440
R12	21	F	230	135	365
R13	21	M	280	130	410
R14	21	M	235	150	385

Table 2 Subjects’ PEFR and Difference from Standard Value

Subject/ Sex	Peak Flow Rate (L/m)	Standard Value[*3]	Difference
R1/M	480	567	-87
R2/M	382	567	-185
R4/M	508	567	-59
R6/M	382	567	-185
R7/M	405	514	-109
R8/M	277	514	-237
R9/M	317	514	-197
R10/M	646	567	+79
R13/M	623	567	+56
R14/M	667	567	+100
R3/F	239	379	-40
R5/F	355	379	-24
R11/F	363	379	-16
R12/F	291	379	-88

2 RESPIRATORY MEASUREMENT

In this research, the subject's peak expiration flow rate (PEFR) was measured because it depends on the patency of the bronchial pathway of the subject[6)]. Decreasing PEFR results from weakness of the breathing muscle[7)], each subject's PEFR was measured three times, and the average value was recorded as his/her PEFR data. Table2 shows each subject's PEFR value and the difference from the standard value[*3)] calculated on the basis of the individual's height. Among male subjects, three PEFRs (R10, R13, and R14) surpassed standard values[*4)], while seven (R1, R2, R4, R6, R7, R8, R9) fell below. All four female subjects (R3, R5, R11, R12) fell below the standard, but with less difference between them than the male subjects. One thing to take into consideration when evaluating three results is that PEFR depends on personal effort[8)]. The results shown above are mainly those gathered at a particular day and time, and vary within subjects.

3 LISTENING EXPERIMENT

3.1 Respiratory Signal Measurement Circuit Unit

Each subject's respiratory timing was examined while he/she listened to a recorded English passage read aloud. To save time, some subjects underwent this experiment in pairs. Everything from the beginning to the end of the experiment was videotaped, including with their permission. After receiving instructions in the experimental procedure, each subject was required to wear a headset and listen to an English dialogue from the pre-2 level English Language Proficiency test.[*4)] The recorded text was approximately 50 seconds long. Then, the subject answered a comprehension quiz. To measure a subject's respiration, an experimental "Respiratory Signal Measurement Circuit Unit (RSMCU) [9)]" developed by the second and third authors was used (Figure 1). Two highly sensitive microphones were attached to the headset so as to measure the subject's respiration: one at the subject's nose and the other at the mouth. This experimental unit successfully measured subjects' average expiration time (AET), maximum expiration time (MET), standard deviation of breathing intervals (SD), synchronized time of the subject's non-expiratory pulse with the text reader's breathing timing (ST), and average respiration interval (ARI). Figure 1 shows the RSMCU. Figure 2 shows a picture of the listening experiment being used on a subject during the equipment. Figure 3 shows an example of the formatted data acquired from the RSMCU. The upper graph is the sound wave signal of the English text reader, with breath timing indicated. The middle graph is the nasal expiration signal of a subject listening to English. The lower graph shows the respiration intervals of a subject listening to English. However, the RSMCU could not successfully examine every subject's respiration. The cross mark on Figure 3 indicates that the unit failed to capture the first respiration interval of a subject. Furthermore, the equipment could not acquire data for R1, R6, R13 or R14.

3.2 Result of Listening Experiment

After data were gathered on all the subjects' respiration while listening to English, the subjects were sorted into three groups based on listening scores on a TOEIC test held on June 6, 2012, which is shown as Table 3.

Fig.1 Respiratory Signal Measurement Circuit Unit (RSMCU)

Fig.2 The Listening Experiment

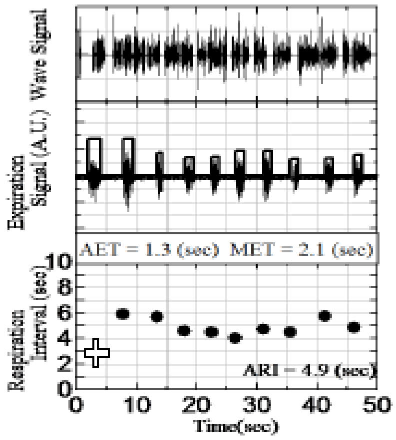

Fig.3 An Example of the Formatted Data Acquired from the RSMCU

Table 3 Groups Sorted by TOEIC Listening Score

Group	Subject	TOEIC Listening Score
Upper	R2, R3, R4	315-360
Middle	R7, R9, R11	260-265
Lower	R5, R8, R10, R12	190-235

Table 4 Subjects' PEFR and Hunchbacked Posture by group

Group	Subject	Sex	PFER (L/m)	Hunch-backed Posture
Upper	R2	M	382	
	R3	F	239	
	R4	M	508	
Middle	R7	M	405	✔
	R9	M	317	✔
	R11	F	363	
Lower	R5	F	355	
	R8	M	277	✔
	R10	M	646	✔
	R12	F	291	✔

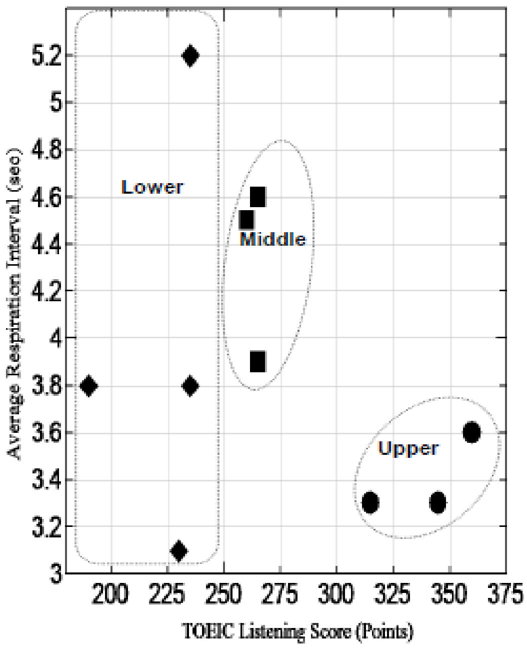

Fig.4 Co-Relation Diagram Between Average Respiration Interval and TOEIC Listening Score

R1, R6, R13, and R14 were eliminated because of failure to acquire their respiratory data with the RSMCU, even though TOEIC scores had been recorded for them. Figure 4 shows the co-relation between a subject's AGI and his/her TOEIC listening score. On the basis of the breathing characteristics of the upper group as seen in Figure 4, it seems that they manage to keep their breathing pace much shorter than the other two groups. According to Brown (1994), in spoken language, because of memory limitations and our predisposition for chunking, we break down speech into smaller groups of words. Clauses are common constituents, but phrases within clauses are even more easily retained and thus comprehended. In teaching listening comprehension, we need to help students pick out manageable clusters of words; sometimes second language learners will try to retain overly long constituents (a whole sentence or even several sentences) or will err in the other direction by trying to attend to every word in an utterance. Figure 4 indicates that the subjects in the upper group manage to keep their breathing pace short in anticipating of the sudden rhythmic changes caused by the prosodic features of English. This being the case, do subjects in the upper group have better respiratory function? Does a hunchbacked posture influence their PEFR value? Next, the subjects' PEFRs were examined by listening posture. According to Kusakari and Sasaki (2003), the hunchbacked position obstructs the expansion of the chest, which causes decreased oxygen uptake and leads to the need for more rapid respiration. Wada et al. (1995) report that the hunchbacked posture has a deleterious effect on air ventilation. Table 4 categorizes the subjects in three groups by PEFR and listening posture. The presence of a hunchbacked posture was identified on the basis of visual judgment by the first author. In no group shown in Table 4 does PEFR show any within-group commonality; thus, PEFR values do not align with the remarkable characteristics observed in the co-relation diagram between average respiration interval and TOEIC listening score. Furthermore, some subjects acquired higher PEFR values even with a hunchbacked posture. That means the hunchbacked posture does not influence the subject's PEFR value (Nevertheless, it is interesting none of the upper group subjects had any hunchback while listening to English.) Thus, the results of the listening comprehension experiment suggest that listeners with higher TOEIC listening scores tend to control their breathing to achieve a short rhythm for dealing with English prosody flexibly, and that this control of breathing pace can be managed with lower PEFR values.

4 READING EXPERIMENT

4.1 Silent Reading: Speed and Chunks

Each subject was examined to identify his/her meaning chunks while he/she read English silently. Data were categorized into three groups—upper, middle, and lower—based on TOEIC reading score and examined to see if any remarkable features could be observed in common within a group. Individually, subjects were required to read two kinds of English text silently and draw slashes in the text to cluster the sentences into meaning chunks as they understood them. The texts were taken from the pre-2 level English Language Proficiency test*[5)]. The subjects started the first silent reading at the instructor's call, drawing slashes. To indicate that they were finished, they put a slash at the end of the text; then, the instructor recorded their reading time. A second reading was conducted in the same way. After acquiring all the subjects' reading data while reading English silently, the subjects were sorted into three groups based on their TOEIC reading scores of TOEIC test held on June 6, 2012, which is shown as Table 5. Table 6 shows the subjects' reading speeds, the number of his/her meaning chunks, and their PEFR values categorized by groups. In the reading experiment, all 14 subjects persuaded the whole procedure.

4.2 Results

As Table 6 indicates, three groups had one or more subjects who hunched their backs while reading silently. No significant difference was observed on reading speed or chunk numbers between hunchbacked and non-hunchbacked subjects.
In the upper group, three subjects (all except R2) read silently with a speed of 70 or

Table 5 Groups Sorted by TOEIC reading Scores

Group	Subject	TOEIC Reading Score
Upper	R1,R2, R3,R4	260-285
Middle	R5,R6, R8,R9, R10, R11	165-205
Lower	R7,R12, R13, R14	130-150

Table 6 Subjects' Reading Speed, Number of Meaning Chunks, PEFR, and Posture While Reading Silently by Groups (Text 1:52Words, Text 2:54 Words)

Groups	Hunchbacked Postures		Silent Reading Speed (wpm)		Number of Meaning Chunks		PEFR (L/m)
			Text 1	Text 2	Text 1	Text 2	
Upper	R1 M	✔	60.0	73.6	12	13	480
	R2 M		44.6	45.0	13	12	382
	R3 F		65.0	90.0	8	10	239
	R4 M	-	72.6	70.4	10	11	508
Middle	R5 F		47.3	37.2	11	13	355
	R6 M	✔	45.9	45.0	12	18	382
	R8 M	✔	39.0	38.1	7	7	277
	R9 M	✔	67.8	68.9	9	8	317
	R10 M	✔	48.0	45.0	15	14	646
	R11 F		74.3	62.3	15	12	363
Lower	R7 M	✔	82.1	87.6	9	10	405
	R12 F	✔	61.2	62.3	8	9	291
	R13 M		55.7	64.8	13	14	623
	R14 M	✔	36.7	32.7	14	11	667

more words per minute (wpm), which are shaded in Table 6. Furukawa and Kawate (2004) suggest that the ability to read silently is positively associated with reading speed.

When reading at 70 wpm, the reader translates each English word into Japanese in his/her mind. Furthermore, if he/she then applies Japanese grammatical word order to an English sentence, he/she reads the English sentence back and forth—a process dubbed "reverse reading" by Furukawa and Kawate (2004)—and his/her reading speed slows down to 50 wpm. The results indicate that the subjects in the upper group seemingly have the ability to read an English text at 70 wpm or over. As for R2, since in this reading experiment, subjects were not given any time limit, there remains the possibility that R2 would have read texts at over 70 wpm, if he had a time limit. Next, the relationship between the subjects' silent reading speed and the number of reading chunks was examined.

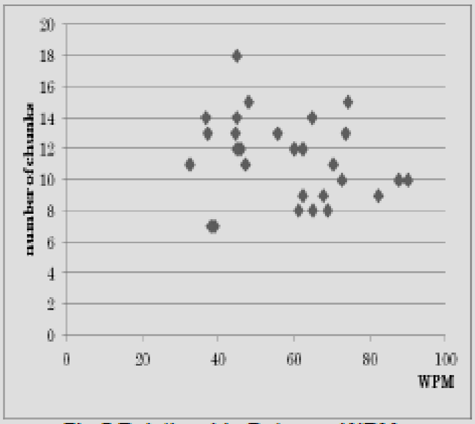

Fig.5 Relationship Between WPM and Number of Chunks

Figure 5 shows this relationship: there is no correlation between these two variables. The data indicate a group of subjects who read faster but did not acquire high TOEIC reading scores (R9, R11, R7), another group of subjects who read with more chunks and slower speed, less than 50 wpm on average (R2, R5, R6, R10, R14), and a single subject who read with fewer, longer chunks, but slower speed (R8). Thus, in silent reading speed, there is no remarkable aspect in common in upper group subjects. As for PEFR, R10 in the middle group and R13 and R14 in the lower group recorded high values; however, they did not achieve a high silent reading speed. That means high PEFR does not indicate high silent reading speed. Again, in this silent reading experiment, there was no time limit set, even though reading time was measured. Therefore, the possibility that subjects might change their reading speed under a time limit was not eliminated. It is necessary to arrange an additional reading experiment with a time limit and compare the reading speed in that experiment with the present result.

5. SUMMARY

We investigated whether there was a relationship between 14 students' TOEIC listening and reading scores, their posture, and their respiration. PEFR values were used to examine respiratory behaviour in a relative manner. In the listening experiment, the result suggested that subjects in the upper-level listening group by TOEIC score manage to keep their breathing pace rather short, anticipating sudden rhythmic changes caused by the prosodic features of the English language. In the reading experiment, the result indicated no correlation between TOEIC reading scores, reading speed, and PEFR.

Acknowledgements

This research was conducted with the assistance of a Grant-in-Aid for Scientific Research (C) 2011—2014 (No. 23520737) from the Japan Society for the Promotion of Science.

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Notes

*1) A current definition is given by Gobet et al. (2001): a chunk refers to "a collection of elements having strong associations with one another, but weak associations with elements within other chunks" (p. 236).

*2) My Trainer: English Trainer for School Use, (2005), ICC, p.39

*3) O'Sullivan, K., O'Sullivan, P., O'Sullivan, L., and Dankaerts, W., find that the choice of best sitting posture varies between countries and disagreement remains on what constitutes a neutral spine posture and what is the best sitting posture (2012). However, in their paper, two sitting posture options out of nine were completely denied as the best postures by 295 physiotherapists. In this paper, the postures similar to either of these, as identified visually, are defined as hunchbacked.

A Hunchbacked Posture

*4) (Eds.) Takamasu, T. & Ando, T. (2008) Guidebook for Instructors of Peak Flow Meter Used for Treatment and Management of Asthma, *Environmental Restoration and Conservation Agency*, p.18.

$$\text{Male (L/m)} = 77.0 + 64.53 \times \text{height (m)}^{3} + 0.4795 \times$$

$$\text{Female (L/m)} = -209.0 + 310.4 \times \text{height (m)} + 6.463 \times \text{age}$$

*5) Ikeda, Y. (2007) Test in Practical English Proficiency, Grade Pre-2 Mock Examination with CD, *Takahashishoten.*