

PERCEPTION OF RHYTHM AND ITS ROLE IN THE PROCESS OF LANGUAGE ACQUISITION

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ABSTRACT

The mode of table tapping, for example, had a striking similarity with the mode of utterance in Japanese in terms of speed and of interstress (-beat) intervals, which eventually concentrated in the area of 400-1,000 msec. in both modes. And more interestingly, the subjects who tapped quickly outstripped the slow tappers of young ages in the ability of learning a new foreign language, even if they are very old, i.e., 80 years old.

Other experiments revealed that, when interstress intervals go out of the central rhythmic area (400-1,000 msec.), intelligibility of the speech abruptly falls in the case of initial stage learners of a foreign language. These and some other evidence seem to throw doubts on the widely spread ideas of gradual perception of rhythm and of the critical period in language acquisition.

INTRODUCTION

Rhythm has been acknowledged to be one of the important, probably universal, principles in spoken language, functioning both as an organizing factor in speech articulation [1], and a guiding principle in the perception of speech [2]. If there should be a possibility that rhythm might be innately acquired or a universal phenomenon as some phoneticians suggest [3], it would possibly play a very important role in the process of understanding sentences and discourses, and even in the process of language acquisition, both of which require far more complicated strategies and cognitive actions than the perception of sounds, or isolated words.

EXPERIMENT I

An English short story (106 words) was composed by the use of the words and sentences which had already learned by the subjects -- Japanese high school students (9th grade) who were learning English (n.=120). The content of the story was original, however. This story was read and recorded by an English speaker at three reading speeds: normal, fast and slow. The normal speed material was then compressed mechanically by Speech Compressor (HITACHI TSC-8800) (Machine fast). These four modes of the material had the following acoustic characteristics as a result of measurement by Visicorder and Electro-oscillograph (Yokogawa, Type 2901, amplifier 3125):

Reading speeds: normal=124.8 words/minute, slow=74.9, fast=198.7, machine-fast=185.8
Frequency of juncture pauses: normal=17, slow=35, fast=14, machine-fast=16
Total amount of juncture pauses: normal=14,098 msec., slow=32,693, fast=7,209, machine-fast=11,071
Interstress intervals (means): normal=574 msec. (S.D.=154.8), slow=568 (S.D.=179.2), fast=446 (S.D.=90.6), machine-fast=359 (S.D.=144.6)

(The phonetic stoppages whose duration was less than 220 msec. were not included in the data on pauses, because this kind of discontinuation often occurred when plosives were made.)

Intelligibility of the four modes of the material was got by asking questions of the subjects in Japanese about the content of the story, as follows:

normal > fast, $p < 0.01$, ($t=3.40$)
normal > machine-fast, $p < 0.01$, ($t=6.18$)
slow > normal, $p < 0.05$, ($t=2.52$)
slow > fast, $p < 0.01$, ($t=5.92$)
slow > machine-fast, $p < 0.01$, ($t=8.70$)
fast > machine-fast, $p < 0.05$, ($t=2.78$)

(A > B in the table means A mode gave more intelligibility than B mode to the subjects who were homogeneous in ability of English.)

Obviously no other factors than interstress intervals (rhythm) can interpret the above-mentioned facts. The speed of utterance and the pausing conditions can never explain the phenomenon of fast > machine-fast, but the interstress intervals can -- they are less than the central rhythmic area (400-700 msec.) suggested by Allen (1975) [4], in the machine-fast.

The author's previous paper [5] shows that pauses help listeners' cognitive processing if normally placed, but too many pauses which were placed at the ends of every word, for example, hinders listening comprehension. The paper also shows that slowly drawled pronunciation which is too accurately articulated has the same negative effect. The reason for this phenomenon can be explained by the fact that, while the interstress intervals of the former material were 574.2 msec., the ones of the latter two were 1845 and 2643 respectively, both of which are off from the central rhythmic area.

Several additional experiences were held in the similar way as Experiment I, changing the conditions of interstress intervals variously and revealed

that intelligibility falls when they go out of the area of about 400-1,000 msec. It may be said in this connection that interstress intervals of the first cry of a newborn baby was around 756 msec. (means).

EXPERIMENT II

Subjects are Japanese with age variety from 18 through 79 years old (n.=30). They were asked to tap a table at a tempo they feel most normal, and then to read "The North Wind and the Sun" by Aesop at normal speed in Japanese. The result is shown at Table 1:

Table 1

Subjects	Tapping (f/m)	Reading speed (w/m)	Age
1	107	211	18
2	105	208	18
3	102	198	22
4	95	192	20
5	100	185	49
6	96	182	43
7	96	180	23
8	90	177	24
9	86	175	55
10	78	173	16
11	70	170	35
12	77	170	14
13	47	170	49
14	75	167	41
15	73	165	57
16	60	164	59
17	45	160	35
18	70	155	17
19	66	148	71
20	90	145	23
21	60	143	39
22	60	143	37
23	60	140	62
24	56	140	40
25	45	136	65
26	49	135	65
27	86	132	23
28	65	130	55
29	48	123	74
30	43	111	78

The rank correlation between the tap frequency and the reading speed is very high ($r_s=0.78$, $t=4.2$, $p < 0.0001$), and those between tapping and age, reading speed and age are $r_s=0.61$, $t=3.28$, $p < 0.02$ and $r_s=0.57$, $t=3.06$, $p < 0.004$, respectively.

Slow, rapid and normal speed tappers, 7 in total, were then chosen from the subjects, and they were required to learn Spanish, which was never learned by any subjects in the past. The content of learning (testing) was. 1) to repeat some Spanish words and sentences without models after having listened to them by a tape recorder five times. 2) to find some grammatical rules heuristically after having listened to some sets of words and sentences. 3) to repeat phonemically minimum pair words after having listened to them five times. All the responses were tape-recorded and scored by two teachers of Spanish. (coefficient of objectivity=0.82)

Table 2

Subjects	Spanish test score	Tapping f/m	Reading condition		Age
			interstress interval msec.	S.D.	
1	108	110	412	15	18
5	102	104	453	15	49
8	98	96	525	21	24
19	77	66	755	21	71
28	59	65	870	30	55
29	51	48	931	31	74
30	57	43	905	30	78
EX	73	75	692	21	79

Relation between the Rhythmic Actions and Language Acquisition

Table 2 shows the very high correlation between the frequency of tapping and test scores, but between age and test score, the correlation is not so high. In order to confirm the relation of neuro muscular ability for rhythmic action with competence for language acquisition, a male subject, EX, who is still quick in action in spite of being 80 years old was asked to join the experiment, which brought forth the result described in the bottom of Table 2 -- his tapping is very smooth and his test score is also high.

We can conclude rhythm is unexpectedly crucial in the process of acquisition, closely connected with human beings' motor actions.

References

- [1] J. Martin, "Rhythmic (hierarchical) vs. serial structure in speech and other behavior" *Psychological Review* 79: 487-509, 1976.
- [2] W. Marslen-Wilson and L. Tyler, "The temporal structure of spoken language understanding" *Cognition* 8: 1-71, 1980.
- [3] M. Studdert-Kennedy, "Speech perception" *Proceedings of the Ninth International Congress of Phonetic Sciences II: 59-81*, University of Copenhagen, Denmark, 1979.
- [3] I. Lehiste, "Isochrony reconsidered" *Journal of Phonetics* 5: 253-263, 1972.
- [4] G.D. Allen, "Speech rhythm: its relation to performance universals and articulatory timing" *Journal of Phonetics* 1: 219-237, 1975.
- [5] M. Kohno, "The effects of pausing on listening comprehension: some psycholinguistic experiments in the case of Japanese learners of English" in T. Konishi (ed.), *Studies in Grammar and Language* 392-405, Kenkyu-sha Tokyo, 1981.