LOW FREQUENCIES AND THE LEARNING RHYTHM

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1. Introduction

In order to introduce the present topic strangely enough, one would have to start by dealing with the reeducation of deaf children. Very often, children suffering from profound sensorineural deafness have some hearing zones left around 500 albeit 250 Hz or below (See Fig. 1). Huizing (1959) and Watson (1961) in two different surveys showed that between 95 and 97% of all the children living in residential schools kept some residual hearing mostly below 500 Hz (Fig. 1).
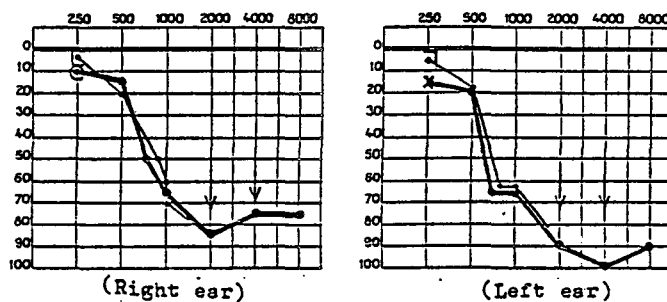

(Right ear)   (Left ear)

Fig. 1 Typical Tonal Audiogram of the Residual Hearing of a Deaf Child, suffering from Sensorineural Deafness (Portmann and Portmann, 1972 p.310)

Therefore, it does not come as a surprise if reeducators of the profoundly deaf children were and are still at present

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in a disarray how to find out proper means to help these chil-
dren. They were, I would say, almost forced to call   on   low
frequencies in the face of failure of other means of   reeduca-
tion. Suffice it to say that the area of hearing is   divided
into the following way. Below 300 Hz there is the so-called
infra-sound zone, between 300 Hz and 3,000 Hz, the conversa-
tion zone where all the phonemes of all the languages are per-
ceived, around 12,000 Hz, the zone of uneasiness and   finally
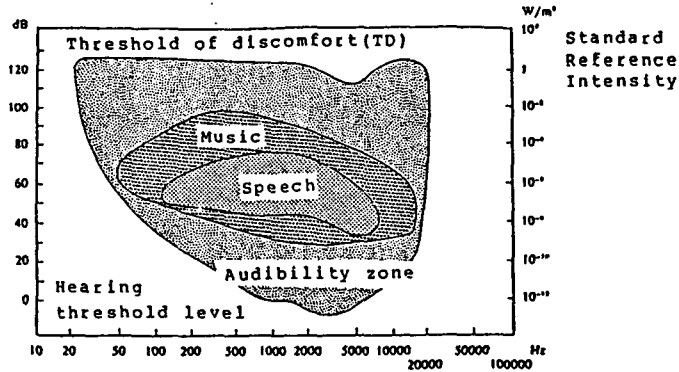around 20,000 Hz, the zone of pain (See Fig. 2).

Fig. 2 Human Hearing Field (Wegel Curve corrected by
Bilsom, Rakowska-Jaillard, 1982 p.18)

Naturally this particular topic would help us, teachers of for-
eign languages, to better understand the eventual role played
by low frequencies, but in this article, I will limit   myself
to the field of foreign languages.

    2. Role of lower frequencies

    To begin with, a brief presentation on the importance of
the role of low frequencies in language learning is necessary.
As early as 50 years ago (1938) Dr. Petar Guberina stressed the

importance of rhythm and intonation in producing and perceiving
speech. As a result of his experience and research, he suggest-
ed that low frequencies are the primary vehicle to transmit
these basic elements of speech (1964). That is why in any ap-
paratus designed under this methodology called the Verbo-tonal
Methodology, you will necessarily find filters going as low as
0.5 Hz. The reasoning behind this is the same as the one meant
for the training of deaf children, aphasia patients and people
suffering from speech handicaps:

> In the early 1950's he [Guberina] began to apply these two
> principles [rhythm and intonation] to the habilitation of
> deaf children who have hearing only in the low frequencies.
> He reasoned that the brain would function best if it were
> to receive the auditory stimuli for which the ear is most
> sensitive; moreover, it would be enriched (in Piaget's term)
> by these optimal stimuli; and with time and training,   it
> would be prepared to respond to more difficult tasks, i.e.,
> less favorable stimuli (Asp & Guberina, 1981 p.2)

Concretely this means that learners trained with low fre-
quencies will be in a better position from the viewpoint of their
brain to learn foreign phonemes, to hear foreign languages   as
they are, I mean, different from their mother tongue. It is as
if both physical and psychological oppositions which these stu-
dents would put up are melting away. Low frequencies have   as
effects of enhancing memorization, a better hearing of the fre-
quencies where phonemes of human speech are found and a better
functioning of the brain, on the whole. Our words are here in-
adequate because at this level we cannot say man "hears" in the
same way as he does in the zone of conversation. More than the
ear alone, the whole body as such is involved. More than hear-
ing sense, proprioceptivity, the sensation of one's own muscular

activity, is working.

Dr. H. Trocmé (1973 p.51) noticed that when her students
were trained with low frequencies they showed a better organiza-
tion of their breathing. This observation is very important sin-
ce they used to become out of breath after 3 of 4 syllables. Ex-
perience shows that young learners ignore how to organize their
rhythmic or breath groups, they ignore also which syllables they
have to stress and which ones not to stress. Low frequencies
draw the learner into the flow of rhythm without him noticing it.
Trocmé proposes as an explanation the fact that they were proba-
bly more preoccupied with the semantic or syntactic rules   than
the acoustic side. By using low frequencies, articulatory   and
respiratory efforts get naturally organized by themselves.   And
words lose their own individuality to disappear within a   rhyth-
mic group. They do not exist anymore, only syllables or   rhyth-
mic groups do so.

At first, it seems hard to believe that low frequencies
below 300 Hz could help the correct perception and articulation
of phonemes whose frequencies are found above 300 Hz,   mostly
around 1,000 or 2,000 Hz. But this is true for all phonemes,
specially in the case of the correct timber of vowels,   in   the
pronunciation of /r/ and /l/, two liquids that can be considered
very close to vocalic sounds. Other rhythms,   other   rythmic
structures would have meant different phonemes and   different
languages. As a scientific explanation for this phenomenon, we
have to acknowledge that phonemes do possess also some frequen-
tial elements even in the infrasonic zone (Ling, 1965   p. 236).
That is why

we attach the utmost importance to low frequencies   which
transmit best rhythm and intonation. It is possible to base
speech on rhythm because rhythm is altogether a biological

and physiological phenomenon. By introducing speech through its rhythmical structure, we affect man in depth. We condition him anew through what is most deeply entrenched in him and from a pedagogical viewpoint, we keep him away for a limited period of time from the situation where he hears phonèmes rather well - the "direct channel" - but less clearly hears rhythm and intonation. Later on this rhythm and intonation shall enrich his possibilities of listening and he will hear within the same spectrum both his mother tongue and the foreign language (Guberina, 1973 p.11, my translation).

3. Background to the present study

Now coming to the problem of learning foreign languages, I would like to introduce some of the research concerning the topic of low frequencies. First there is the study of Cohen, Starkwether (1958) who used a 600 Hz low-pass band. Under these circumstances, it is difficult to accept the results of their research since, as I said before, this zone is partially covering the lower section of the conversation zone. Three other studies have extracted the fundamental frequencies of amplified filtered texts and with the help of a generator have transformed them into pulse trains, Atkinson (1968), Bonte (1975) or into a sort of "buzz" tone (Ohala, Gilbert, 1979). As far as I know, only Bush (1967) and Richardson (1973) called on low-pass filtered signals for their experiments. Another study (Maidment, 1976) used a laryngographic apparatus for his analysis.

Some experiments have introduced the mother tongue

among the languages to be examined, some others avoided it. Some
presented long texts, others very short ones, and finally some
others presented both... (Ohala,Gilbert). Some researchers have
examined phonetically very similar languages, for instance White
and Black English (Richardson) or American English, British Eng-
lish and Indian English (Bush). Other researchers on the other
hand, chose purposely languages that were very different from
one the other, for instance English, Cantonese, Japanese (Ohala
& Gilbert). In some experiments, the subjects were given a cer-
tain period of training before the beginning of the experiments
and in other cases, the experiment started right away after two
or three trials. Finally, most of the experiments used a text
that was read while only one (Ohala & Gilbert) presented a free
conversation. Within such a background, it is very difficult,
for the time being, to make a valuable comparison between these
endeavours or draw a line of conduct that would be clear enough.

The purpose of my research is twofold: to know whether
Japanese students, beginners of French language, could identify
the rhythm and prosody of this language
  1) without any previous training
  2) with the sole information provided by filters without any
     further transformation.

  4. Method

There were 54 subjects for the first and second tests
and 47 for the third one. 7 subjects were then eliminated since
they had not understood well the requirements for that particu-
lar test. They were 18 or 19 years of age, were specialized in
the study of French language which they had studied for 3 months
on an average of 10 hours per week according to a structuro-global

audio-visual (SGAV) method, "De Vive Voix". One characteristic of this method is that special care is taken to secure a perfect recording, specially for the prosody of French language.

For Test I, students had two choices:

a) an English sentence followed by a French one (EF)

b) or a French sentence followed by an English one (FE)

In Test II, the students were forced with a quadruple choice:

a) two French sentences (FF)

b) two English sentences (EE)

c) an English sentence followed by a French one (EF)

d) or a French followed by an English one (FE)

Finally, the students had this time six possibilities of choice:

a) French-English-Mandarin (FEM)

b) French-Mandarin-English (FME)

c) English-French-Mandarin (EFM)

d) English-Mandarin-French (EMF)

e) Mandarin-French-English (MFE)

f) Mandarin-English-French (MEF)

There were 10 sentences for each test, 30 altogether. They were registered on a Compact disk (SONY CD 502 ES). Their meaning was more or less linked with the language of tourism. For instance, "I'd like to change 100 dollars", "I'm checking out now" recorded in English, French and Chinese. The presentation was a haphazard one.

Each choice set was presented twice on a low-pass band of 300 Hz with a slope a 60 dB. The filter apparatus was specially built up for this experiment by Hideaki Tomoyori. I repeat again, so doing, only prosodic features like rhythm, intonations, pauses, accentuated versus non-accentuated syllables, etc., could be perceived, phonemes and meaning of these stimuli were eliminated.

The subjects had no special training in the listening to French below 300 Hz during their three months of schooling. However before each test, in order to familiarize them with this new way of listening a brief training session was given. It occured this way. Two sets of sentences similar to the ones to be used in the tests were presented twice non-filtered, then twice filtered in each of the following steps:

1) with a 300 Hz low-pass filter, 60 dB per octave combined with a high-pass filter of 3,000 Hz at 30 dB per octave

2) the same except that the high-pass had a roll-off of 40 dB

3) the same except that the high-pass had a slope of 60 dB per octave

4) finally the low-pass filter alone.

The two chosen sentences used for pre-testing were: "It's too expensive for me. Can't you make it cheaper?" and "How much is together?"

5. Results

Here are the results I obtained under these circumstances. The symbol * is followed by the number of correct responses. Symbols E means English, C, Chinese and F, French. The numbers preceeding these symbols refer to the sentences in the Annex 1.

Test I where an average discrimination of 67.6% was reached is above the chance level of 50% and is therefore statistically significant ($p < 0.005$). Considered from a chance level the discrimination of Test II would have been 25%. With 36.3%, it is above this level and is therefore also statistically significant ($p < 0.005$). In Test III, one accommodation had to be made. The Chinese language was recognized almost 97% of the times. This could be attributed to its particular rhythm, its rapid change of

Test I: Results   (54 subjects)

Stimuli		Responses	
		F-E	E-F
1.	6F-4E	* 35	19
2.	3E-1F	28	* 26
3.	2F-2E	* 38	16
4.	4F-9E	* 20	34
5.	7F-3E	* 44	10
6.	1E-5F	7	* 47
7.	7E-8F	11	* 43
8.	3F-8E	* 38	16
9.	6E-9F	17	* 37
10.	8F-5E	* 37	17

Average discrimination: 67.6%

Test II: Results   (54 subjects)

Stimuli		Responses			
		F-F	F-E	E-F	E-E
1.	2F-3E	8	* 16	21	9
2.	4F-6F	* 18	10	18	8
3.	1E-7F	28	3	* 23	0
4.	9E-6F	9	11	* 22	12
5.	5F-2E	16	* 29	2	7
6.	1F-7E	5	* 15	17	17
7.	9F-4F	* 19	14	9	12
8.	6E-9E	9	17	19	* 9
9.	7E-8F	15	8	* 26	5
10.	3F-8E	16	* 19	12	7

Average discrimination: 36.3%

tones, its speed, all cues that made Chinese melody easily re-
cognizable. If we omit Mandarin from Test III and take   into
consideration only English and French we come to a result quite
comparable with the one obtained in Test I 67.6% and 66.2% in
Test III.   All three tests have reached statistical significan-
ce and Test III confirms what was shown by Test I.

Test III: Results (47 subjects)

Stimuli	Responses					
	F-E-M	F-M-E	E-F-M	E-M-F	M-F-E	M-E-F
1. 4F-6M-9E		* 30		17		
2. 5F-8E-3M	* 37		10			
3. 7M-1F-5E					* 18	29
4. 6M-6E-9F	1		1		16	* 29
5. 2E-7F-1M	4		* 43			
6. 7E-2M-1F		22		* 25		
7. 9F-4E-0M	* 36		11			
8. 5M-2F-1E					* 31	16
9. 2M-3F-2E	2	3	4	2	* 27	9
10. 8E-8M-8F		12		* 35		

Average discrimination without Mandarin: 66.2%

But on the whole one could characterize this task as dif-
ficult. Would it not have been possible to make it easier? Pro-
bably so. If the students had been trained to listen to prosodic
cues of French right from the outset of their teaching when their
attention did not yet become blurred, most probably the results
of the tests would have improved. It is one thing to listen to
prosodic cues and another to pay attention to vocabulary, morpho-
logical or syntactic rules. After three months of training, it
is already too late to concentrate only on prosody. The students

are already used to looking for other information.   I   would
venture to suggest that a group of students starting the study
of a foreign language would perform better provided they   re-
ceive right at the outset proper training for these global ele-
ments of a language. Only a longitudinal study could show this
more clearly.

Second, the recording of the French sentences did   not
constitute the right sample of French rhythm meant for begin-
ners. I do not mean to say that there was some influence of a
kind of dialect or some wrong pronunciation of phonemes.   On
the contrary, everything could be classified as an honest sam-
ple of standard modern French. But the different sentences did
not well represent the basic prosodic features of this language.
For instance, specialists agree on saying that the last sylla-
ble of each rhythmic group has on an average a duration of two
and half times longer than any previous syllable. Intensity is
steady all through except at the end where the last accentuated
vowel is only 0.5 dB lower than the preceeding ones. These two
factors are just the reverse in English where the accent very
seldom falls at the end and the intensity is changing all   the
time in a significant manner, 4.4 dB of difference between str-
ssed and unstressed vowels (Delattre, 1966 p.187). A   better
recording, I mean a recording that would have taken more in ac-
count these two factors, would undoubtedly have enabled   the
subjects to make a clearer distinction between English and Fren-
ch. In other words, the recording like the one I was using was
meant for advanced learners of French prosody, not beginners.

I would like to add a last remark concerning the type of
sentences selected for the tests. They could not properly be
called genuine spoken French, English or Chinese since   they
dealt with a very peculiar situation, tourist matters. Undoubt-
edly senctences blended with a more important part of affectivi-

ty would have helped subjects to select the proper   language
with more accuracy.

What I could say by way of conclusion is that   people
learning a foreign language have a special "feeling" for   the
information transmitted through low frequencies below 300 Hz,
mainly prosodic features, and that this feeling may develop na-
turally to a certain extent as it was shown by the above-men-
tioned experiment. No doubt it could also be further nurtured
and trained in such a way that it may become helpful in differ-
ent ways beyond what is commonly expected.

Finally, I would like to quote a poem on rhythm composed
by a medical doctor working in a psychiatric hospital in   New
York, Doctor Samuel Anderson. This poem is appropriate at the
end of this article for we know that rhythm and low frequencies
form the head and tail of the same coin:

Before words come to me,
I get a sense of rhythms,
Something like a time-schema,
Before the words,
I have had a sense of form,
Something into which
The words, as they appear, can fit.
(Quoted from Ferrand-Vidal, 1982 p.11)

APPENDIX

English Sentences

1E I plan to stay for 6 days.
2E I have nothing to declare.
3E I'd like to change 100 dollars.
4E Where is the tourist information office?
5E I made a reservation in Tokyo.
6E Are there any letters for me?

7E   I'd like a wake-up call tomorrow at 6 A.M.
8E   I'm checking out now.
9E   What are some special products of this town?

French Sentences

1F   J'ai l'intention de rester pour 6 jours.
2F   Je n'ai rien à déclarer.
3F   Pouvez-vous me changer ces 100 dollars?
4F   Où est le bureau de renseignements?
5F   J'ai fait la réservation à Tokyo.
6F   Y a-t-il une lettre pour moi?
7F   Réveillez-moi à 6 heures demain matin, s'il vous plaît.
8F   Je vais régler ma chambre maintenant.
9F   Quelle est la spécialité de cette ville?

Mandarin Sentences

1M   我预定住六天.

2M   没有什么要申报的东西.

3M   请先换一百美金吧.

4M   观光指南所在哪儿?

5M   在东京定好了.

6M   有我的信吗?

7M   请明天早晨六点钟叫醒我。

8M   请给我结账.

9M   这个城市的特产是什么?

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