

**L. A. TOMATIS**

THE ASSIMILATION  
OF  
MODERN LANGUAGES

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As its title indicates, the present text does not attempt to describe all the consequences of the "Tomatis Effect". Only those relating to the acquisition of modern languages will be considered here.

For its application to the medical, psychological and teaching fields (dyslexia, stammering, deafness, etc..), the importance of which is becoming more and more apparent, reference to the bibliography at the end of the text is recommended.

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## INTRODUCTION

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The need for learning foreign languages is becoming increasingly apparent internationally, and has given rise to a large number of systems, almost all of them described with more or less emphasis as "audio-visual".

On examining these "miracle" methods one is immediately struck by the inadequacy of the systems, many of which have no scientific basis and ignore the elementary psycho-physiological laws of language, particularly the relationships between hearing and phonation, that is to say between the ability to understand a language and the ability to reproduce it.

For far too long, modern languages have been approached like dead languages, ploughing through words which have disappeared from the spoken language (cf. Shakespeare) and whole arsenals of disused grammatical rules.

Since the last war, following the extraordinary development of communication facilities, the rise of tourism and international trade have widened the need to speak easily and directly to people of other countries. As a result the "audio-visual" methods were created.

However, these were all too often merely the spoken or visual versions of an old method of teaching.

It is now time to move on to a new stage and, using the latest discoveries concerning the hearing/phonation relationship, to go beyond the idea of "learning" a language to reach the stage of "assimilating" a language, a process much more complete and, though this seems paradoxical, much easier.

The prime rôle played by the ear in learning languages - whether the mother tongue or a foreign language is involved - is familiar to all those concerned with the question of verbal assimilation. Nowadays it cannot be denied that the great open door to language is the ear. Modern languages are learned by hearing, and by hearing correctly.

The master-key to this learning process is therefore ensuring that the student has audition of a high quality. In this way even the audibility of the language studied becomes greater and hence more efficient, all its acoustic nuances being constantly discerned. Therefore it is necessary on the one hand to know the auditory capabilities of the student and on the other hand to enable him to enter the sound world of the ethnic group whose language he wishes to master.

We cannot stress this point too strongly. It is pointless to teach a language to a student who does not hear it or who hears it indistinctly. The finest language laboratories are useless when no account is taken of this essential factor. This is why we shall refer in this text much more to "assimilating" than to "learning". We consider this distinction to be a basic one.

The apparatus called the "Tomatis Effect Electronic Ear" enables the student to hear in the same way as, for example, an Englishman, or a German, or a Slav, and consequently, according to Tomatis' Laws which will be studied in the text, to speak and to reproduce correctly the language being studied.

The object of this booklet is not to recommend one method rather than another but simply to try to establish the basic principles which must govern any serious study of a modern language.

The laws which are the basis of this study will be considered in their general context and in their special application to the teaching of modern languages. They highlight the prime rôle of the ear in verbal acquisition, which led Tomatis to sum up in the words : "It is the ear that speaks".

Hence, in a first section, we shall consider the principles of the "hearing-phonation" relationship. The second chapter will consider the way in which these laws can be applied to the assimilation of a modern language. Chapter III will determine the "envelope curves" of several European languages and thus outline the main differences between them. The fourth chapter will be devoted to the description and the operation of the Electronic Ear.

The three final chapters will cover mainly the use of this new equipment with present methods and the pre-conditions of this use (audio-vocal testing).

In our conclusions we shall endeavour to consider briefly the psychological implications of the assimilation of a language.

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It was while he was engaged in Industrial Medicine that Dr. Tomatis put forward the hypotheses, known from then on as Tomatis' Laws, which concern the relationships between hearing and phonation. These discoveries were of considerable importance and enabled the modification of one or the other of these two essential functions to be envisaged, with wide significance in the fields of therapeutic medicine and teaching.

#### A - FIRST LAW

In examining workers suffering from occupational deafness after protracted exposure to noisy machinery, Dr. Tomatis observed that the ear defects were always accompanied by some vocal deficiency. He therefore wondered whether the defective hearing was not the cause of the alteration in the voice.

A more detailed analysis of the machinery causing noticeable loss of auditory perception of certain frequencies enabled him to note that the frequencies not perceived by the ear were precisely those which were absent from the vocal spectrum of the subject. This was the first fundamental discovery, the first of Tomatis' Laws, which was expressed as follows :

"THE VOICE CONTAINS ONLY WHAT THE EAR HEARS" or, in more scientific language, "The larynx emits only the harmonics that the ear can hear".

To this curious and interesting phenomenon Raoul Husson, a notable specialist in the psycho-physiology of the voice, gave the name "The Tomatis Effect" in a paper to the Académie des Sciences of 25th March 1957 (1). At the suggestion of Professor Monnier, R. Husson was able to verify in the Sorbonne Physiology Laboratory the fact noted by Tomatis in 1952 (2) and then in 1954 (3) and express it as follows :

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(1) R. Husson : "Experimental study of modification to vocal pattern under the effect of accompanying auditory stimulation". Note by M. Pierre P. Grasse.

(2) A. Tomatis : "Effects observed in auricular lesions noted in test bench workers and those using the voice professionally". Bulletin of the SFECMAS (Nord Aviation) Medical Study and Research Centre - September 1957.

(3) A. Tomatis : "Directing rôle of the ear in the determination of normal (speaking and singing) voice characteristics and in the origin of its disorders". Oto-Rhino-Laryngological News - Masson, Paris 1954, p. 264.

"If a subject emits a vowel sound into a microphone the output of which passes through a system of filters which cuts out a band of frequencies before returning it to headphones placed on his ears, the band which was cut out disappears from the spectrum of the vowel sound emitted by the subject. In the same way, in the case of a subject with an auditory scotoma, the harmonics of the auditory islet are absent from the voice of the subject."

Raoul Husson, in a paper to the Académie Nationale de Médecine meeting on 4th June 1957, reverted to this study under the title "Phonatory modifications of auditory origin and their physiological and clinical applications" (1).

This first Tomatis' Law thus sheds light on the striking similarity which exists between the auditory curves and the vocal emission curves of subjects naturally or experimentally handicapped.

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#### B. - SECOND LAW

The second of Tomatis' Laws is really the corollary to the first. It is stated as follows :

"IF A DEFECTIVE EAR IS GIVEN THE CAPABILITY OF HEARING THE LOST OR IMPAIRED FREQUENCIES CORRECTLY, THESE ARE INSTANTLY AND UNCONSCIOUSLY RESTORED TO THE VOCAL EMISSION."

The comparison of the emission curves before and after the use of the Tomatis Effect apparatus - this having the effect of restoring hearing in the impaired frequency bands - easily demonstrates the resulting recuperation of the vocal pattern.

Raoul Husson, in his paper of 4th June 1957 at the Académie Nationale de Médecine, describes this second law as "a phonatory physiological and physiopathological consequence of the Tomatis Effect".

He notes in particular that "the excito-tonic effect of auditory stimulation in the 2,500 - 3,000 Hz band enables the subject to recover his normal vocal pattern".

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(1) Note by M. Moulonguet - Extract from the Bulletin of the Académie Nationale de Médecine, volume 141, Nos 19 and 20.

## C - THIRD LAW

The third of Tomatis' Laws, called "THE LAW OF THE RETENTION EFFECT", raises the possibility of conditioning the self-listening faculty, leading, by educative reflexotherapy, to modification of the phonation.

It may be stated thus :

"AUDITORY STIMULATION MAINTAINED FOR A DETERMINED PERIOD MODIFIES, BY THE RETENTION PHENOMENON, THE SELF-LISTENING FACULTY OF THE SUBJECT AND CONSEQUENTLY HIS PHONATION."

On the one hand the functioning of the ear brings into play the modifying muscles of the osteo-muscular system of the middle ear. The phonatory system, on the other hand, works under the action of a series of muscles which operate the larynx, the buccal cavity, the tongue and the lips. These hearing and phonation muscles are themselves controlled by an innervation mechanism under the same neuronal command. In adults, this neuro-muscular system is perfectly adjusted to the ethnic auditory pattern corresponding to the mother tongue. However, if the hearing is modified by introducing into the self-checking circuit an "Electronic Ear" tuned to a different way of speaking, to a foreign language for example, it is the whole neuro-muscular circuit of the subject which starts to work at the foreign rhythm and thus a remanence is gradually built up by cerebral memorizing of this new activity and by muscular action.

This third law has a wide application in the field of accelerated assimilation of modern languages. It calls for conditioning of the self-listening faculty necessary for the learning of a modern language in all its phonetic and semantic parameters.

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### AUDITORY LATERALISATION

One of Tomatis' fundamental discoveries concerned the predominance of one ear over the other in the language acquisition process. He was thus able to define the prime rôle played by the LEADING EAR in the location of sound and in the speech chain (1).

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(1) A. Tomatis : "The Leading Ear" - Bulletin of the SFECMAS Study and Research Centre - July 1953.

The theory of auditory lateralisation put forward by him in 1951 and verified by a lengthy series of experiments constitutes one of the essential fundamentals of language learning, whether of the mother tongue or of a foreign language.

Pursuing his researches in this direction, Tomatis was then able to show that language is regulated entirely by the right ear (1), which always acts as the leading ear in the control of the various parameters of language : intensity, timbre, intonation, inflection, semantics.

This is of major significance in the field of language assimilation.

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### AUDITORY SELECTIVITY

We should mention finally auditory selectivity, which introduces the concept of quality, analysis and auditory acuteness within the specific range of each language.

Tomatis, having noted that "while an individual does not reproduce the sounds he no longer hears, he does not reproduce all those which he does hear", put forward in 1954 (2) the theory that the ear has a certain faculty which enables it to perceive a variation of frequency within the sound spectrum and to discern the direction of this variation.

He was also able to show, in a research procedure which has become classic, by the analysis of the envelope curves of the acoustic spectra of each language, that the various ethnic (3) ears have very different selectivity bands, within which the frequential relationships of each operate.

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(1) A. Tomatis : "Dyslexia" - Language Centre Publications, pp. 46-49.

(2) A. Tomatis : "Studies of auditory selectivity" - Bulletin of the SFECMAS Medical Study and Research Centre - October 1954.

(3) This word is used here in its simplest sense ; it does not imply belief in any particular ethnological doctrine ; it simply means the ownership of a known collective linguistic unity. It is possible that the English ear is congenital among Englishmen in the same way as a certain colouring or a certain behaviour pattern ; it is also possible that that it is "learned" through the effect of the restraints of the socio-historic system. André Le Gall (Inspector-General of Public Education) : "The correction of certain psychological and psycho-pedagogic deficiencies by means of the Tomatis Effect apparatus".

In this way, for example, the Italian ear registers selectivity between 2,000 and 4,000 Hz while the French ear has selectivity between 1,000 and 2,000 Hz.

The Russians, on the other hand, have the advantage of a very great range covering sounds from the lowest-pitched to the highest.

This matter will be raised again in Chapter III with the study of the envelope curves of each language.

Tomatis' various laws and theories which we have briefly discussed, and which imply an actual conditioning of the vocal emission by the hearing, have been used for many years in other fields, notably in the medical treatment of various disorders such as :

#### DISORDERS OF PHONATION AND THE SPEAKING OR SINGING VOICE :

- timbre disorders : aphonia, dysphonia,
- articulation disorders : lispings, hissing, slobbering,
- rhythm disorders : dyslalia, impediments, speech-blocks, stuttering.

#### SPOKEN AND WRITTEN LANGUAGE DISORDERS :

- late speaking, inability to speak,
- dyslexia,
- dysorthographia.

#### EXPRESSION AND BEHAVIOUR DISORDERS

#### PROBLEMS OF ADAPTATION TO SCHOOL

#### HEARING DISORDERS :

- professional deafness,
- psychological deafness.

This booklet, we must again emphasise, does not pretend to study all the applications of the Tomatis Effect, but merely to cover the use of these laws in the field of the acquisition of modern languages. We shall therefore limit our subject to the way in which the Tomatis Effect - in conjunction and not in competition

with the classical methods of language teaching - can, with an apparatus called an Electronic Ear, enable foreign languages to be better absorbed through the rapid acquisition of what is called the "ethnic ear".

Phonetic exercises carried out with the help of the Tomatis Effect Apparatus provide a conditioning of the ear which leads the subject to hear foreign phonemes correctly and to pronounce them with exact intonation.

Thanks to this training, the student will spontaneously adopt the PHONETIC POSTURE and, hence, the PSYCHOLOGICAL POSTURE necessary for the learning of the language he wishes to acquire, whatever the method used.

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## II. THE ASSIMILATION OF MODERN LANGUAGES AND THE TOMATIS EFFECT

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First of all, what does "assimilating" a language mean ?

To assimilate\* a language is to be able to render it "ad integrum". It is not a question, we believe, of reproducing merely the letter, but also the spirit. In other words, to possess a language one has decided to absorb is to use it to express, to think and to live by. "For a modern language is not, as was believed for a long time, a collection of words following rules, but a combination of signals and of groups of sounds for communicating to others one's thoughts, feelings and wishes.

A language, to be "meaningful", that is to say understood by those with whom one wishes to communicate, can only use signals referring to the realities which they designate". (1) And to the most courteous and agreeable grammarian in the world addressing us in a manner as refined as it is incomprehensible we would say, as Pantagruel said to Panurge : "My friend, I have no doubt that you can speak several languages, but tell us what you have to say in a language we can understand".

These signals, to be understood and assimilated immediately, without effort, without analysis, without distortion, must above all be correctly heard. But it is also necessary that the pupil should be able to reproduce them, pronouncing them with the utmost exactness of sound, rhythm, timbre and articulation.

In the same way as a pianist must try to reproduce a musical passage with an overall effect, automatically, as a whole which is not broken down, the modern language student must seek to hear and to reproduce as a whole, unconsciously and without analysing them or breaking them down, with their rhythms and their intonations, the groups of sounds which are at first strange and in opposition to his own linguistic reflexes.

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(1) R. Vettier - Inspector of Education and Honorary Director of the Ecole Normale Supérieure of St-Cloud. "The Tomatis Effect and Language Study".

\* To assimilate : in French "Intégrer"

This is an ideal process of assimilation rarely achieved at the very first with subjects who do not have a particularly well-adapted ear, sensitive to the different frequencies of the language being studied. But in the majority of cases, the linguistic experience poses from the beginning such difficulties that learning a language, apparently the simplest thing, becomes a real adventure. All kinds of insurmountable obstacles arise, and of the original dream cherished in the heart nothing remains except a secret desire to communicate, gradually fading in the face of a multitude of vain efforts.

For many pupils, inability to speak foreign languages arises in this way, confining them for ever within the impassable limits of their mother tongue, while some, endowed with exceptional ability, emerge free to revel in the language of others. It is as if some mysterious faculty has freed their tongues.

However, all things considered, learning a language should be something easy and the enthusiasm of the child when he enters the first year of secondary education, where he is finally going to plunge into a language other than his own, shows how much goodwill is available at the outset. Alas ! What disappointment, which will remain the most common attribute of language study.

Whence comes this break-down, which can cause the bright hopes of linguistic discovery to disappear in a few weeks ? It is not a question of intelligence. It seems absurd that a pupil should lack it only in just one subject such as modern languages. It will certainly come to the aid of the unfortunate pupil who is trying desperately to acquire, through a thick inextricable fog, the necessary rudiments so as to obtain at the end of his school career a non-eliminating pass mark, often compensated by success in other subjects. By saturation, by osmosis, some fragments will get through to him, in an atmosphere of strain and defeat.

But what remains at the end of this initiation ? A nightmare, an unspeakable repugnance coupled with a bad conscience at having missed out on valuable lessons and a secret fear of having to return to them later.

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Therefore it would seem opportune to reconsider the problem of learning modern languages while trying to elucidate what constitutes assimilation, verbalised information, in the most general sense. Whether we are concerned with a mother tongue or a foreign language, the process of the basic mechanism remains effectively the same.

There is no longer any doubt that a modern language is assimilated by means of the ear. This auditory acquisition, though it may well be aided by *text and pictures, is essential and basic.*

But what does correct hearing mean ? A person does not seem to be deaf because he finds it difficult to learn English. However, one has to accept the fact that, in this case, he is selectively deaf to English.

To understand this new concept which is somewhat disconcerting at first sight, it should be remembered that the ear has been conditioned to language only secondarily. "Language appeared as the final stage of a transcendent adaptation which modified for acoustic purposes a neuro-muscular system intended for swallowing and breathing". (1)

The acoustic potentialities of the surrounding zones enabled Man to control with delicacy and flexibility the sound range of his own language. But what a different acoustic world to that of another language !

Not very long ago, the author of an article entitled "The Chinese in Paris" noted the need for a "made-to-measure" auditory correction for Chinese who find French particularly difficult. He gave as a reason for this need that "having heard only the sounds belonging to our mother tongue, not only our ear but also the auditory centres of our brain are conditioned".

This proposal, beyond any doubt a correct one, calls for some explanation : our auditory system being conditioned by the ethnic environment, we are insensitive to the intonations, the sound variations, that we are not accustomed to hearing.

Our language lacks the foreign consonances that our ear cannot pick up, the auditory deficiency necessarily being translated into a vocal deficiency. This is what the Tomatis Effect means as summed up by : "The voice contains only the harmonics that the ear can hear".

"The impression that we receive in hearing a foreign language, even without understanding it" M. Charles Bailly has already noted some years ago (2), "spring

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(1) A. Tomatis : "THE EAR AND LANGUAGE" Editions du Seuil. "Rays of Science" Collection, No. 17.

(2) Charles Bailly "LANGUAGE AND LIFE" pp. 94-95.

to a large extent from an unconscious comparison with the phonological system of our own language, and the pleasant or unpleasant feelings that it gives us arise from this ; someone who speaks this language does not generally feel anything similar, and his acoustic impressions are of quite a different kind.

A Frenchman studying Russian will be struck by the frequency of palatal sounds and sibilants, by their contrast with the guttural sounds and by the special music of the intonation, simply because he unconsciously perceives a considerable difference between this pronunciation and his own. However, the Russian who, in speaking, produces these impressions in the Frenchman does not notice anything of the kind, since he is quite accustomed to all these things" (1).

Another eminent phonetician, M. Pierre Fouché (2) also commented, rather felicitously, that "the impression that we normally have of a modern language is an acoustic impression. We hold in our minds what is generally called its "accent", attributing to it a certain "colour". We further say that it is sonorous, soft, monotonous, etc."

Thus we are all conditioned to hear in a certain way, and the speech system, adapting itself to the same requirements of the surrounding milieu, makes the subject pronounce his words in the same way. "Hence", wrote Wilder Penfield (3), "all Swedes speak English with a Swedish accent, and the French, Germans and Chinese speak with their own accent. Everyone has noticed this. Even though they may travel round the world, Cockneys, Scotsmen and Irishmen - not to mention Canadians and Americans - betray their origin by their way of speaking learned in childhood."

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We have thus arrived at a general law which does not apply only to certain nationalities. Possessing the ear of our own ethnic group, we all by nature find some degree of difficulty, depending on our nationality, in learning foreign languages ; the difficulty is greater or less, as we shall discuss later in more detail, according to the extent of the difference between the auditory curve pattern of our language and the one we are learning.

In this respect we are all in some way "bad hearers" and hence we can all benefit from the methods used by phoneticians to "re-educate" the hearing of subjects with auditory disorders. It certainly seems that the only remedy is to "force" the ear to hear that which it cannot hear naturally, which can only be done by artificial devices.

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- (1) Our underlining.
  - (2) Pierre Fouché : "French Phonetics Today" II - Review of Courses and Conferences, 15th April 1937, p.38.
  - (3) Wilder Penfield and Lamar Roberts : "SPEECH AND BRAIN MECHANISMS" Princeton University Press (1957).

It seems strange, at first sight, to call on therapeutic procedures in a case where the matter is usually seen as a teaching problem in combining the goodwill of the subject (or just his will to learn) with increasingly sophisticated teaching techniques - and we are not referring here of course to the "miracle" methods promoted by clever and tempting advertising which gratifies the laziness of the pupil by fostering the insidious illusion that it is possible to learn without effort.

There is no doubt that nothing is acquired without effort. But neither is it sufficient to do like Rimbaud and shut oneself up in a cupboard equipped with a book of grammar and a will of iron, swearing not to come out until one has mastered the language one wants to learn.

It is true that, to acquire a foreign language, one must have the "will" to study seriously ; but one must also have the "ability" - in the most physical sense of the word - to learn, that is to say "to hear and to reproduce", then to listen and repeat, and finally to hear and to listen to oneself repeating or reproducing (1).

Hearing and reproduction - these are the two basic factors in which the Tomatis Effect is involved, with its principle of the regulation of hearing and phonation. In applying this principle to language learning, we come to the idea of supplying a self-control circuit which enables the language pupil to get the maximum out of the sound message which reaches him and to reproduce it "ad integrum".

In modifying the subject's hearing, in teaching him to hear in a different way from that to which his mother tongue has accustomed him, one enables him to speak in a different way, in the different style of expression which is characteristic of the language being studied.

This audio-vocal effect causes modification to timbre, to the constitution of the speech system, to the usage of the over-lying and under-lying laryngeal resonance cavities, to laryngeal tone, to the breathing, and to the mimetic faculty, as well as modifications which progressively extend by reflex action to the whole morphological structure of the subject.

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(1) A. Tomatis : "THE EAR AND LANGUAGE".

These modifications show clearly the fundamental influence of the auditory receiving system in the assimilation of a language with regard to bodily behaviour and function, to psychological registration and to the releasing and then the building up of psychosomatic induction circuits.

It is easy, from this data, to evaluate the important consequences of such a process.

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As we mentioned in Chapter I, Tomatis showed experimentally, from the audio-vocal counter-reactions which are the basis of his laws, that any modification of the auditory pattern invariably causes a modification of the vocal function. Hence, it may be safely inferred that all vocal action corresponds to a specific auditory action.

Using this principle, Tomatis was able to distinguish between the ethnic auditory patterns corresponding to the precise characteristics which we shall discuss in this chapter.

Detailed analysis of the various parts of the speech chain could be made from the images obtained by panoramic analysers and audiographs able to break down sounds in the same way as a prism splits light into a rainbow spectrum. With this equipment, it was possible to display visually various sound frequencies, quantitatively distinguishing the relative values of each and separating the various elements of a phrase in terms of frequency, intensity and duration. From the sound-recordings and sound-pictures thus obtained, it was possible to discover the envelope curves (Fig. 1) of the average frequency values often found in the analysis of phrases in the same ethnic group.

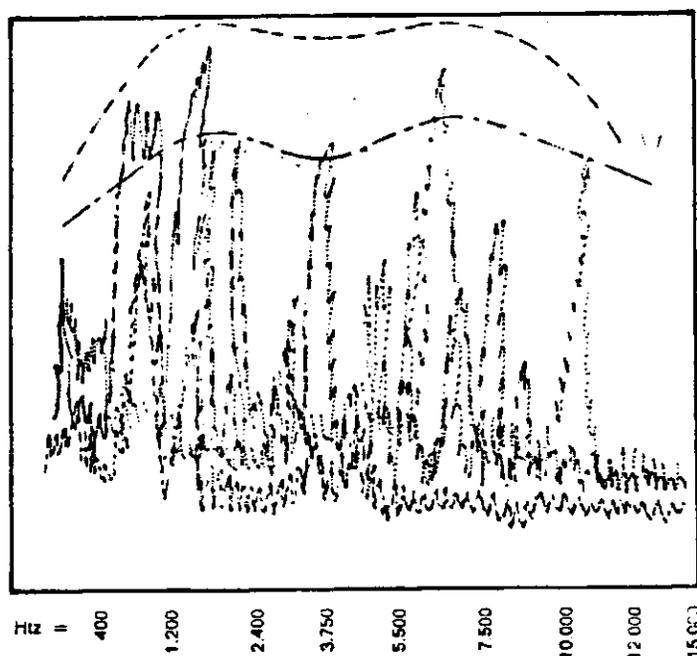


Fig. 1 - Example of a sound-picture showing the envelope curve.

In this way, for example, the most common level of the largest frequency grouping for French is in the neighbourhood of 800 to 1,800 Hz, while for English it is from 2,000 to 12,000 Hz. This simple scientific observation enables us to predict that it is as if a Frenchman becomes practically deaf when he hears English.

Moreover, the historical study of languages shows us how the evolution of groups of humans through the ages has caused each of them to adopt quite involuntarily a certain speech system composed of vowels and consonants, the pronunciation and timbre of which are clearly differentiated between one group and another.

From childhood, the ear models its sensitivity on the sounds it hears and one can easily show by audiometric study that the auditory sensitivity curve is closely related to vocal emission curve of the ethnic group.

In other words, to hear this collection of frequencies correctly, without the risk of introducing distortion through the auditory reception system which consequently acts as a filter, we have to adjust- or, better, to condition - ourselves to hear in such a way that our optimal sensitivity coincides with the frequencies required for our vocal emission. Hence by "hearing-phonation" self-control the subject's ethnic ear produces his ethnic phonation. It must be remembered that a way of hearing corresponds to a way of speaking.

Tomatis later showed and verified that by treating the way of hearing one could modify the way of speaking.

Before dealing with this modification process, we shall try to explain exactly what is meant by the "way of hearing".

This is specified scientifically by the sensitivity curve of the ear in relation to the different frequencies it can hear. This curve is called the "audiogram". We show below, for example, the characteristic audiograms of various ethnic groups.

THE  
FRENCH  
LANGUAGE

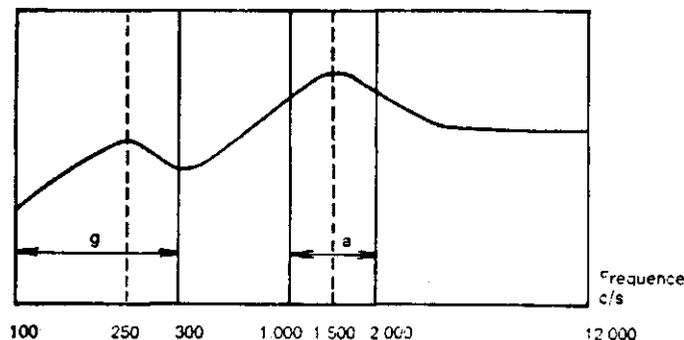


Fig. 2 - French curve.

Figure 2 shows the specific auditory curve of the French ; it can be superimposed, as a whole, on the phonogram of the language, the "linguagram", as it were. It is obtained by combining the largest possible number of auditory response curves of a given ethnic group. The typical French profile being considered here has two peaks - actually two areas with high points - one at 250 Hz in the low frequencies (g) and the other at 1,500 Hz in a higher zone (a) between 1,000 and 2,000 Hz. The difference in intensity between these two levels is about 20 dB. This latter peak at 1,500 Hz explains, because of the relative drop towards the high frequencies that goes with it, the existence of nasals in the French language. By counter-reaction, the presence of this nasal tendency in the spoken language causes ipso facto the appearance of a characteristic peak at 1,500 Hz in the corresponding audiogram.

### THE ENGLISH LANGUAGE

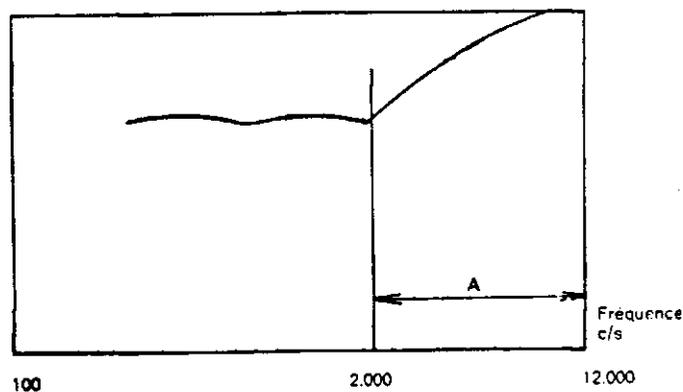


Fig. 3 - English curve

It may be noted from this profile that the main characteristic of this type of hearing is great sensitivity to high frequency sounds.

From 2,000 Hz the curve shows a clear progression of the order of 6 dB per octave, which continues beyond 10,000 Hz, which means that hearing of this kind has a response curve comparable with that of a high fidelity amplifier.

The result is that the sensitivity above 2,000 Hz is so exceptional that modulations at this frequency level are particularly enhanced. Consequently the English language is rich in sibilants. This increase in the breadth of the language itself and, by counter-reaction, the emphasis on high frequencies in the whole vocal pattern, explain the systematic diphthongisation of vowels. These, while present in the initial spectrum, run from the root to the frequency band above 2,000 Hz.

The high frequency range perceived by the English ear causes the bucco-pharyngeal system, by audio-vocal counter-reaction, to have a

structure such that the root, which is necessarily in the low notes because of the limited capacity of the larynx (300 Hz), cannot be maintained in its initial emission because the ear does not "select" it. A marked slide towards the high notes is thereby engendered, which is the cause of the diphthongisation. (1) Looking at it from another point of view, if one compares this auditory band with the previous one, that is to say comparing the English ear with the French ear, it follows that they are not easily reconcilable ; it is no secret, in fact that English is difficult for a French ear to follow.

It may be noted that the American language, which has a lower band than English with a high point at 1,500 Hz, is easier to a French ear than Oxford English. In both languages - French and American - there is a nasalisation indicating increased sensitivity in the same range.

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#### THE GERMAN LANGUAGE

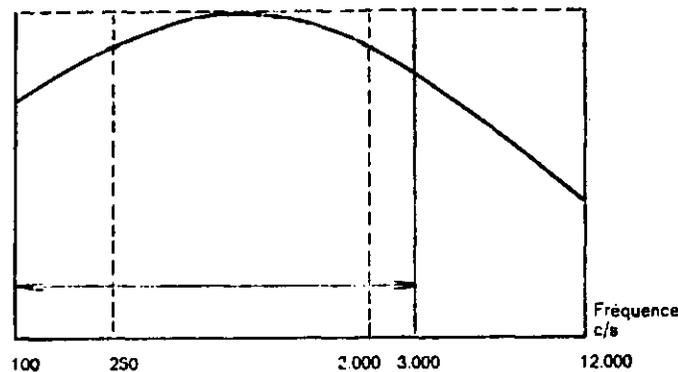


Fig. 4 - German curve.

Figure 4 is the average curve of German hearing. It shows the wide range starting in the low notes and spreading to 3,000 Hz. Sensitivity is greatest from 250 Hz to 2,000 Hz with its highest point between 500 and

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(1) Important note : The distance between the root - initially the same in all languages, and always in the low notes - and the selective range of any particular language explains the greater or lesser difference between the written reproduction of a language and its pronunciation. This modification is all the greater as the difference is larger : for example, Spanish, mainly based in the low notes (as we shall see later), is written almost as it is pronounced, while English has the maximum degree of discrepancy between the spoken language and the written reproduction.

1,000 Hz. The wide range of German enables it to handle the phonemes of other languages easily, provided these are within its registering band.

In addition to this wide range there is another very important characteristic of the German ear : a relatively long latency time (1). These two parameters - size of the range and latency time - involve in the vocal emission a pharyngeal thrust peculiar to Germans. This pharyngeal thrust is also in our view associated with the postural reflex observed in this ethnic group.

However, this audio-postural reflex is not observed only in Germans. It may be said that each ethnic group has the posture of its language which, let us remember, is the consequence of its way of hearing.

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### THE SPANISH LANGUAGE

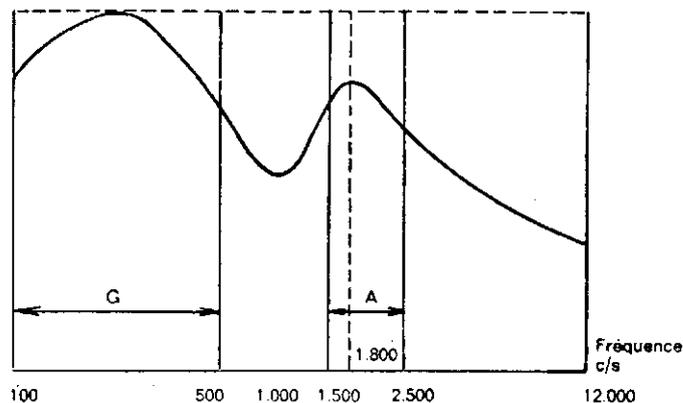


Fig. 5 - Spanish curve.

Figure 5 is the curve of Spanish hearing. It shows the high sensitivity of this hearing within a wide low-note band (g) extending to 500 Hz and, at a lower level of intensity, in a narrow band from 1,500 to 2,500 Hz rising to a peak at about 1,800 Hz. Sensitivity is much reduced in the high notes. The 250 Hz peak introduces the "jota" into the audio-vocal reaction, while the absence of receptivity in the high above 2,500 Hz explains the heaviness of Spanish sibilants : the evolution of the f into an aspirated h. The diagram

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(1) Important note : We shall describe later what we mean by "latency time". At this point we shall simply say that it refers to the self-hearing time of a subject.

shows clearly why Spaniards have difficulty in assimilating foreign languages.

We have outlined in Chapter I the theory of auditory selectivity. Taking the experimental study of these different languages further, it is noted that there are also very great difference in relation to the selectivity of the various ethnic ears. People of some nationalities have very restricted selectivity and in others it is more extensive. In Fig. 6, for example, there is a comparison of the Italian ear and the French ear from the point of view of their respective selectivities.

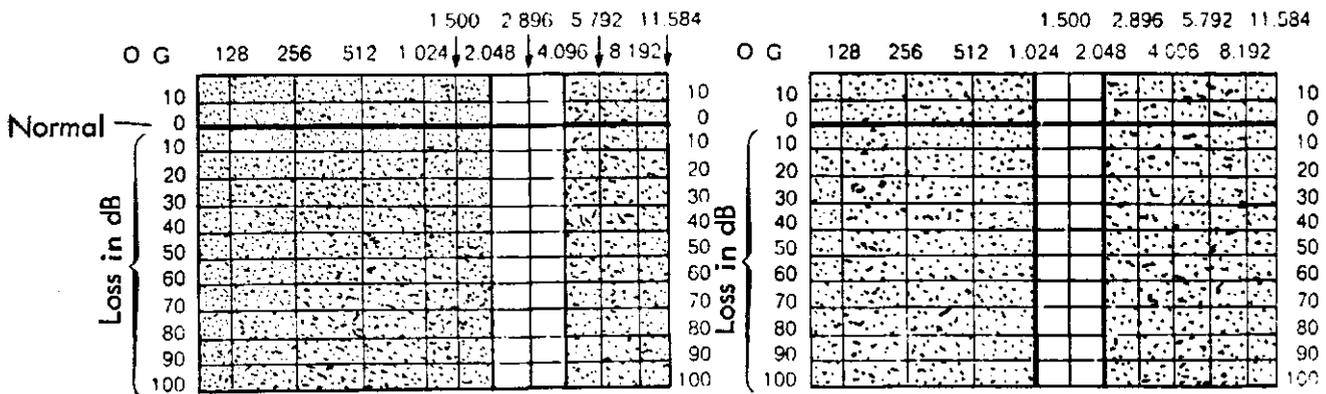


Fig. 6 - Selectivity of an Italian ear.  
The range is from 2,000 to 4,000 c/s.

Selectivity of an ear of the French type, within the limits 1,000 - 2,000 c/s.

It will be seen that the selectivity of the Italian ear is from 2,000 to 4,000 Hz. It is nil between 1,000 and 2,000 Hz, while the French ear on the other hand is well-endowed between 1,000 and 2,000 Hz, which may explain the appearance already noted of nasals in the French language.

The Slavs on the other hand have wide selectivity with greater emphasis in the low notes. Their very wide sensitivity, as opposed to that of the French and the Italians, enables them to discern all consonances. This is easily shown by reference to Figure 7 showing the selectivity range of a Russian ear, extending from the low notes to they very high ones.

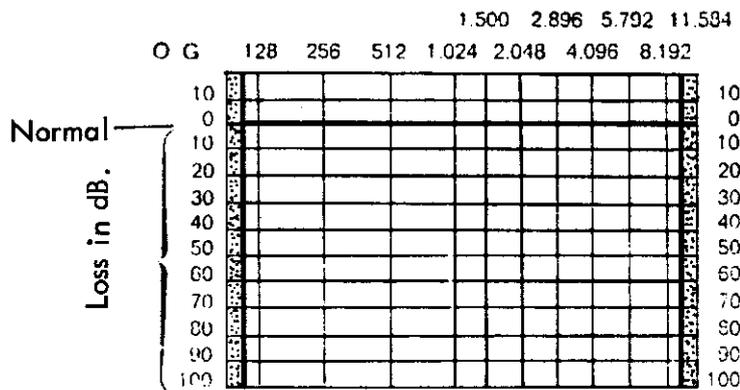


Fig. 7 - Selectivity range of a Slav ear extending from the low notes to the very high ones.

It is this faculty which enables the Slavs to register the whole range of linguistic sounds. Their facility for learning foreign languages is well known. This phenomenon, which we often admire and envy, is due simply to their high auditory receptiveness.

In order to avoid making this study too lengthy, we are restricting ourselves to considering just a few examples. It is clearly necessary to study from the audio-psycho-phonological point of view all the tongues used by human beings. Our research which at that time had covered some hundreds of languages enabled us to distinguish only 12 different ways of hearing, each group showing a different combination of the two parameters : range and latency time.

Hence for example the Arabic language has a Spanish-type range and a German type latency time. The Portuguese language has the characteristics of a Slav language (range and latency time) so that it sounds like Spanish self-controlled by a Slav ear. It is interesting to verify this experimentally by passing a Portuguese sentence through filters with the response curve of a Spanish ear. The sentence then becomes very easily comprehensible to anyone who understands Spanish.

This brief analysis of some ethnic audiograms enables us to appreciate the fundamental differences which exists between the various ways of hearing of subjects who speak different languages.

From these diagrams, techniques of auditory conditioning were established,

taking into account on the one hand the specific curves of each language and on the other the more or less rapid and complex accommodation time characteristic of the language studied. Each language has in effect an average emission time for each syllable, called the "latency time", conditioning the response to the laryngo-resonential adaptation which is the origin of intonation.

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After 1952, as a proof and an application of this theories, Dr. Tomatis concentrated his research work on the setting up of apparatus to modify a subject's way of hearing and, consequently, his way of speaking.

He was also concerned to provide real audio-vocal conditioning making the ear accommodate so as to hear in the way that is typical of a language and producing the corresponding vocal pattern.

A. Tomatis, in a paper to the Académie Nationale de Médecine (1), set out in 1960 the fundamental principles of audio-vocal conditioning applied by means of this apparatus. We give below a summary of this paper.

" A vocal action  $G^1$  corresponds to an emission  $E^1$  in response to an overall auditory pattern  $A^1$ . To substitute for the emission  $E^1$  AND HENCE THE VOCAL ACTION  $G^1$  a vocal action  $G^2$  and an emission  $E^2$ , it is necessary to condition the hearing to a new method of accommodation which determines the way of hearing  $A^2$ .

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To carry out this conditioning the following assembly was set up (Fig.8) :

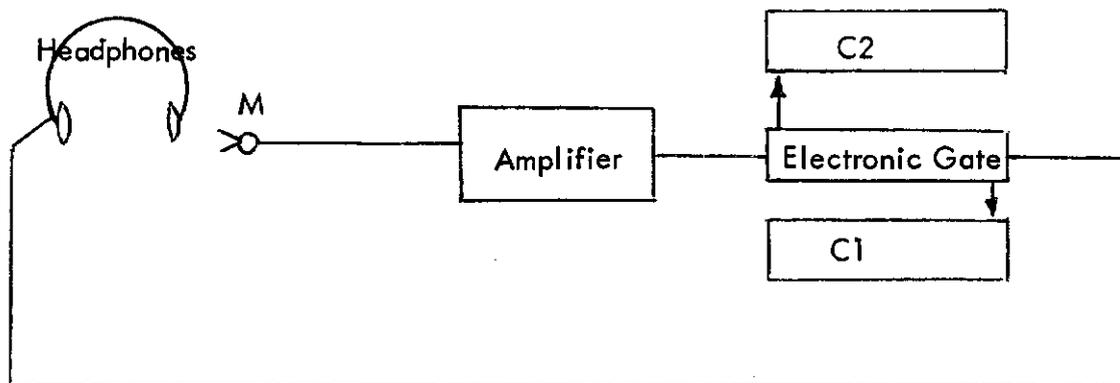


Fig. 8

(1) A. Tomatis : "Audio-vocal conditioning" - Bulletin of the Académie Nationale de Médecine, volume 144, Nos 11 and 12, pp 197 to 200 - Presented by Professor A. Moulouquet.

- A microphone M feeds an amplifier from which two different circuits emanate, these circuits providing two channels which do not function simultaneously.
- For a given intensity, adjustable as required, channel  $C^1$  alone is open. It is set in such a way that it puts the ear in a state of complete relaxation. The tympanum is thus at minimum tension, in a state of non-accommodation. It may be said, by analogy with vision, that it is at its "punctum remotum". Hence it reaches a state of total relaxation before stiffening to the sound determined by the setting of the upper channel. When a sound is emitted by the subject or from another source such as a tape recorder, as soon as it adds complementary intensity to the pre-existing ambient noise, channel  $C^1$  closes and only channel  $C^2$  is open. This second electronic channel will force the ear into another way of registering which has been previously chosen and which corresponds to the emission of the language being studied.

The opening of channel  $C^2$  is done by what is called a "gate" system, so that it is possible to change automatically from the way of hearing  $A^1$  inherent in vocal action  $G^1$  to the way of hearing  $A^2$  corresponding to the desired action  $G^2$ .

When the sound emission terminates, the consequent reduced intensity switches the system over the other way and  $C^1$  opens while  $C^2$  cuts out. The cycle re-starts every time the subject wishes to speak, and the conditioning takes place very quickly. In the first few days, after a half-hour session there is a retention of about half an hour. After two weeks the retention is permanent.

Furthermore, the gate can rapidly become a conscious phenomenon and can give the subject at will the ability to hear what he wants.

With the aim of afterwards modifying the rhythm and intonation of the chosen language, the operating times of the gate were chosen to correspond with the characteristic latency time of the language. It should be remembered that each language has in effect an average emission time for each syllable : 0.15 seconds for French, 0.20 for English and so on.

For those who find this explanation somewhat tedious, one could say, less scientifically, that : The Tomatis Effect Electronic Ear makes it possible to give any pupil, even difficult ones, a predetermined type of hearing, thus making him hear with the required accommodation.

How is this "education" carried out ?

The Electronic Ear is essentially an educational auditory device. Now, it is known that human hearing is only the result of extensive use of the 8th pair of cranial nerves. These, which originate in the sensorial organ of the ear, are situated in the inner ear and project into the telencephalon at the language acquisition centres.

This sensorial organ par excellence also behaves like a piece of skin, highly specialised for the detection of variations in acoustic pressure. But it is valuable only in so far as one knows how to use it. In the same way, excellent sight is useless if the eyelids remain closed ; or, better still, a perfect retina will not be of use if the corresponding lens cannot focus the image. Putting it another way, the optic nerve - the retina for this purpose - is of value only because we know how to use it.

The same applies to the auditory reception system, which must adapt itself to its sound environment. It is the middle ear which has the capacity to adjust and it is this which we are concerned with in using the Electronic Ear.

The middle ear adapts itself by contraction of the malleus muscle and of the stapes muscle, the first acting on the forced convexity of the tympanum which thus behaves as an acoustic lens, a kind of auditory crystalline lens, and the second, that of the stapes, adjusting the play of the inner ear which, as if it were a prism but with an apex angle consisting of two or three turns of a spiral, can spread out the range of sounds into an acoustic spectrum, a kind of sound rainbow.

This accommodation, fairly rapid and complex, determines the spatial position of the ossicular chain and allows the opening of the appropriate auditory range, enlarging the opening membrane according to the requirement.

The Electronic Ear forces the ear to act in this way. In modifying the range at will, one "opens" - the word is not too strong - the ear to the chosen sounds of a language. Whether it is a matter of assimilating a mother tongue or acquiring a foreign language, the process is the same. To open oneself to a language means, above all, connecting oneself to the wavelength of that language. But to be absorbed and then reproduced correctly, the oral message must first be heard correctly and this is what the Electronic Ear makes possible.

By a set of filters, the apparatus in the first place makes an auditory membrane opening possible to one range or another, a simple action which produces a laryngo-resonential response adjusted to the use of the filters.

Secondly, it establishes the latency time inherent in the chosen accommodation, which conditions the response time of the laryngo-resonential adaption, the source of intonation, as mentioned at the end of Chapter III.

The Electronic Ear thus enables this way of hearing to be imposed on any subject, however difficult, obliging him in this way to perceive sounds according to any desired accommodation, according to the auditory membrane opening to the breadth of range and the latency time inherent in this accommodation.

This preparation is essential for the learning of a foreign language. As soon as the message is perceived correctly, the assimilation is immediate and the reproduction perfect because phonation is closely connected with auditory perception and any modification of the hearing causes ipso facto a modification of the various parameters of phonation : rhythm, intensity, melodiousness, etc..

The acoustic structures of these parameters impress on the ear their effect in relation to the coding that they determine. They stimulate the conditioning which prepares the sensorial cells for selective excitation at one frequency or another.

Therefore, if one introduces into the auditory self-control circuit an Electronic Ear adjusted to another way of speaking, say to a foreign language, the subject's whole neuro-muscular circuit starts to work to the foreign rhythm. It is this gymnastic exercise - for this is what it really is - which makes us hear and speak "in a certain way".

The following diagram shows how hearing/phonation self-control is affected by the intervention of the Electronic Ear, by unconscious mimesis (Fig. 9).

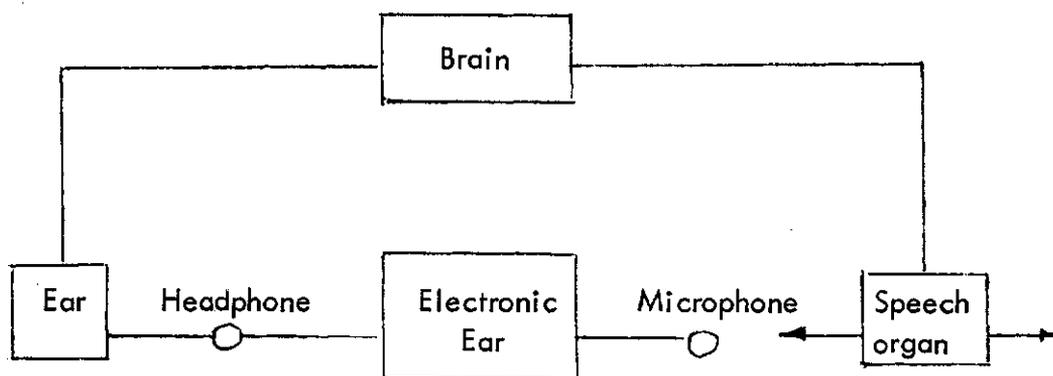


Fig. 9.

Anyone who has acquired this "auditory automatism" is definitively conditioned. The whole of his neuro-muscular circuit which has worked to a foreign rhythm will gradually put itself into a state of retention, by the

cerebral memorisation of this new activity and by muscular effect. From then on the subject will be compelled, so to speak, to hear perfectly and to pronounce foreign phonemes and semantemes with total correctness and exact intonation, whether they are given to him as examples to imitate or whether he has to speak the foreign language with no other guide than the sound image supplied by his auditory memory.

In short, it is as if he has been given what others are pleased to call the "gift of languages". But this gift of languages, which, as is well known, is the gift and the prerogative of the Slavs and which we have clearly seen in the audiogram of the Russian ear, is really only a matter of particularly wide-range hearing, with the membrane opening wide to encompass the range of other languages. From the idea of a gift of languages, surrounded by mystery, we have come to the conception of an aptitude, innate or acquired, for hearing languages.

From now on, a Brooklyn American or a Cockney Englishman, fitted with headphones and placed in front of the Electronic Ear's microphone, will end up speaking the Queen's English with the purest Oxford accent, once the filter system has imposed this way of hearing on him.

This is what should happen, though much less intensively, in traditional language study. We know that it is beneficial, if not always practical, to study a language in its country of origin, thus immersing the ear in the desired ethnic ambience. However, it is very exceptional for a Frenchman taken to London to acquire an English accent immediately, while this phenomenon can happen rapidly by using an Electronic Ear and remaining in France.

As soon as the subject speaks, as soon as he brings the speaking process into play, his hearing is modified so that all sounds must pass through a selective channel which is in accordance in a pre-determined manner with the characteristics of the language being studied. The object of the device is to impose on the auditory system of the subject the type of hearing of the inhabitants of the country the language of which he is studying by "opening" his ear to the frequency bands which he did not hear before. The Tomatis Effect explains that phonetic initiation is in this way achieved instantly, without requiring any kind of effort from the language student to reproduce the sounds and groups of sounds which had until then been foreign to him. It is as if the organs of his audio-vocal system and all the cerebral zones involved were immediately adapted, trained and strengthened.

This is one of the most dramatic experiences he can undergo. An English phrase, for example, spoken by the teacher using these techniques, is almost immediately reproduced by the student with astonishing accuracy. The most striking effect of this is the psychological freedom that such a process gives.

With former language teaching methods, it was often noted that the subject under instruction was inhibited by the fear of ridicule arising from his inability to reproduce the required sounds "ad integrum". The use of the Electronic Ear nowadays not only avoids this additional difficulty but also gives the student a feeling of satisfaction.

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The conditioning to which the ear is subjected during the assimilation of the chosen language can be effected in two ways :

- the subject, fitted with a headset connected to an "Electronic Ear and Teaching Device" to provide correct hearing, repeats what the teacher transmits to him, the auditory assimilation taking place simultaneously with the actual study of the language.
- or,
- the subject works alone to acquire this conditioning, the apparatus transmitting the phonetic elements directly to him from a tape recorder and opening his ear to correct hearing of the foreign language.

Experience shows that, with a normal student, only fifty to a hundred half-hour work periods with the Electronic Ear are needed to create definitive retention effect by cerebral memorisation and the engagement of muscular action, and this aptitude - this "gift" - may then be considered permanent in respect of the language studied.

Several consequences arise from this :

1. As oral expression is unquestionably linked to a certain physical behaviour and mimetic faculty, there is justification for believing that the subject acquires to some extent, along with the power of expression, the physical behaviour of those whose language he studies (1).
2. Furthermore, the intellectual, sensual, moral and social make-up of an individual is to a large extent the product of linguistic habits representing the way in which the national character has developed over the centuries. In the same way this physical behaviour, the consequence and the expression of a particular mental attitude, predisposes the language student to adapt himself progressively to the behaviour of the foreigners whose language he is learning until such time as a profound reflex understanding of the semantemes enables

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(1) See Chapter II, page 14

him to penetrate further into their spirit and to gain an intimate comprehension of their ways of thought, feeling and action.

3. From the ease with which, thanks to the use of the Electronic Ear, the subject is able to pronounce properly, there follows an improvement of auditory memory, a basic and indispensable attribute in language study. It is clear that one should not minimise the importance of the contribution made by the subject's own personal efforts, but since his motivation is undoubtedly a major factor, it should be sustained by the suppression of the initial inhibitions. These inhibitions stem from the unintelligibility of the spoken language being studied and hence from the subject's fundamental incapacity to reproduce it.

Without the conditioning, the unintelligibility itself inhibits the student from trying to make articulate utterance when he knows himself to be incapable of controlling it properly. In effect, it seems pointless to him to wear himself out repeating sounds, without being able to distinguish them and reproduce them easily.

In conclusion, to sum up the merits of the Electronic Ear as an indispensable introduction to any language study, we may repeat the words used by Dr. Tomatis in addressing an audience of experts at the Palais de l'UNESCO in 1960 (1) :

"The Electronic Ear enables one to create the ambient climate so indispensable to the psychological assimilation of a foreign language. In addition, its effect is highly conducive to a feeling of well-being due to :

- the ease of elocution it provides
- the automatic impetus it gives to the speech organs, which immediately adapt to the usage of the chosen language
- the rapidity of assimilation which it causes, which can often be disconcerting.

In a sense, Tomatis concluded, we are re-creating the original auditory assimilation conditions, the conditions that enabled us to learn our mother tongue.

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(1) Congress of Modern Language Teachers : "Electronics in Modern Languages" Conference (held at UNESCO on 11th March 1960) of the Modern Language Teachers Association (APLV). Published in the Bulletin of the Union of Associations of Former Pupils of French High Schools and Colleges - March 1960.

## V. THE ELECTRONIC EAR AND AUDIO-VISUAL TECHNIQUES

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The value of the new audio-visual techniques applied to the assimilation of modern languages cannot be too highly stressed.

As the term "audio-visual" indicates, this kind of teaching involves the two principal sensory organs involved in the acquisition of knowledge : hearing and vision. However, although from the visual point of view the object is achieved by allowing the student to examine the image of the object being studied, as far as hearing is concerned considerable uncertainty remains with regard to the assimilation of the oral message. One need only observe the extraordinary distortion produced in the mouth of the subject when he repeats the message to realise to what extent, because of the laws regulating direct hearing/phonation relationships, it has not been heard.

It was precisely to overcome this problem that the use of the Electronic Ear was introduced into these techniques, for although it is true that some new approaches in language teaching have failed over the last ten years, and many language laboratories have fallen into disuse, many others remain, so that these learning techniques may be considered as extant methods of acquiring a well-structured, well-articulated, well-assimilated language.

Without raising these techniques to the status of a universal solution, we feel it necessary to make this point and to discuss the conditions under which this linguistic initiation should take place. We shall endeavour to show the various aspects of true assimilation so that audio-visual techniques can, in the eyes of our readers (or rather in their ears), occupy the important place they deserve in modern teaching.

To achieve this it is necessary to analyse in detail the psycho-physiological processes involved in the acquisition of a foreign language.

Nowadays the language laboratory is a valuable aid to teachers and students because of the conditioning of the auditory and visual centres it brings about. We have deliberately mentioned hearing before vision as a reminder that to learn a language one must first hear it.

The introduction of the Tomatis Effect Electronic Ear into this current science of teaching is very important because of the considerable sensorial assistance it provides in the transmission of the sound message and its integral reproduction. It ensures perfect hearing of all the elements of the spoken chain which are specific to the language being studied and, by counter-reaction, enables the language student to reproduce exactly what he has heard perfectly. Thus, by using a tape-recorder - Electronic Ear apparatus, acquiring a language becomes easy.

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We shall now consider the conditions under which audio-visual techniques should be used, bearing in mind that their object is to provide the student with not only some reinforcement of the basic course being given by the teacher but also practice in the language by means of practical work.

The subject, left to himself with the apparatus, follows with his eyes the image which is projected for him while the corresponding text is fed into his ears through a headset connected to a tape-recorder. It is important to note here the advantage of this individual instruction which enables the student to use the machine according to his personal rhythm, without intervention from outside, at a rate of progression determined by his own speed of assimilation.

This sets up a pattern of voluntary, easy, pleasant, enjoyable repetition. Is not all linguistic acquisition the most absorbing game there is, provided it is done properly? However, the fragility of the new-born child in the make-up of his audio-vocal circuit increases in the adult.

This is because the adult has stronger inhibitions: his social position causes him to stiffen, his fear of ridicule alienates him from the game of linguistic construction. His habit of always bringing his intelligence into play to assimilate something new is not only useless but actually impedes his progress.

Furthermore, what matters at the beginning is the laying of this track, this network which must gradually establish the various lines and the layouts of verbal flow. Semantic crystallisation will then follow, without confusion or hustle. It is useless, in fact, to hope to understand everything from the very first. This is not how a man begins to learn his mother tongue. Of course the need to make rapid progress affects this first stage, but what is the point of hurrying? It is quite clear that the adult speech system, long accustomed to the use of the mother tongue, does not need as long as that of an infant to develop its auditory and verbal structures. The maturity of the adult enables him to progress through the various stages very quickly, but not to miss any out.

Among these stages, the essential one is auditory assimilation. It is of no importance if a student is creating a mental image of the visual image presented to him on the screen which is slightly different from that created by his neighbour. The structure of vision gives everyone a practically identical overall value.

It is not the same with hearing. With current techniques it is not known how the auditory reception system, the essential element of the audio-phonatory system, functions and analyses. On its adjustment, and on that alone, depends the whole process of the voluntary acquisition of articulatory movements which only remotely involve the normal automatic movements.

Language is made - and this should constantly be born in mind - only from movements organised secondarily, highly developed, and which are only the attribute of Man in so far as he makes full use of his faculties.

If the auditory reception system is defective, or fixed in one position and only one, without the possibility of unconscious modification of its kinesthetic position, all practical methods used will have no effect. All that the ear registers, however much improved, will merely pile up, like many other things, at the back of a cupboard, awaiting, under a film of dust, some new chance impulse.

It will be not so much the method being used which is to blame, but the factors involved in auditory assimilation. All the ingenuity used in the science of teaching is useless if the way in, that is to say the ear, remains closed to the linguistic message. It is first necessary to ensure that the way in is wide open, that the hearing is ready to receive the special sounds of the language it must assimilate. Otherwise, all efforts will be in vain.

This is why the "Electronic Ear" should be used in conjunction with the language laboratories' tape recorders. Enabling the auditory assimilation factors to be modified by the electronic gate it contains, the apparatus allows another way of hearing to be superimposed, involving a different listening technique and thus establishing a variation in the control mode on which the continuation of the initial phenomenon depends.

The surprising results which these new audio-vocal techniques give arise simply from the fact that they create electronically the acoustic absorption environment which is indispensable to the replacement of the auto-control system. The remainder - the phonation - must follow naturally.

There is no doubt that the Electronic Ear will be even more effective if it is used in conjunction with a logical method of language teaching, based on progressive and co-ordinated assimilation of meaningful word groups. The teaching problem remains, and we cannot emphasize too strongly the need to add to these techniques a teaching method which takes into account the deep-seated mechanism of language assimilation.

Language laboratories have precisely the object of promoting these techniques over a wide field of sensory assimilation, without which any language learning will be useless.

As mentioned above, a modern language is learned by listening ; the role of the ear, in speech, has nowadays been shown to be a major one. The ear must not only capture the sound, work on it, transform it, weigh it and analyse it, but must also distribute it within the compass of the sensory nerve cells the excitation of which by the induction of many circuits determines the definitive sound image. The ear is the orchestral conductor of the spoken word in all its aspects : the volume of the voice, its tone and the rhythm of delivery depend on it.

It is therefore important to ensure the perfect behaviour of the ear when it is fed the unusual information of the language being studied, which calls for an auditory posture different in every way from that which the initial language, the mother tongue, has determined. The laboratory must enable the ear to open wide its auricle to the linguistic information and to automatically adjust its opening to the information band of the emission. It must also make it possible to restrict the emission of repetitions made by the student. All phonetic action, in fact, must be controlled by the auditory reception system which guides the development of articulation to the point of integral restitution.

Thus the student must in turn hear himself. To speak, as we have said several times before, is to hear, and to speak in a certain way is to hear in a certain way. At the time of the emission, the ear has the power to act as a pilot, cybernetically adjusting the intensity, the timbre, the intonation and the inflection, and to provide semantic control (1).

To speak a language means to adapt one's own hearing to the acoustic frequencies of that language. To achieve this the ear adopts a specific posture for each language, enabling it to modify at will the articulatory counter-reactions which vary the emission and hence the verbal output, evidence of a fresh neuronal coding.

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(1) And even to modulate the extra-linguistic affective charges. The study of this point is beyond the scope of the present work.

In this way the ear shapes its hearing to the specific range of the language to be assimilated. This results in a way of hearing which moulds itself to the envelope curve of this new idiom. The emitted sounds of a language consist in effect of multiple "sound objects" with a demeanour, a size and a morphology specific to the language.

The Electronic Ear is intended to take the pupil into the sound world of those whose language he wishes to adopt.

From experience we have established some rules which must be understood in order to obtain the required effectiveness :

1. The Electronic Ear should be used for a preliminary period before the first actual language lessons, purely in order to condition the hearing and speech systems.
2. In dealing with students who have already started studying the language and who have defective pronunciation and hearing, the best method is to start from scratch and not to continue the actual language study until after a period of use of the Electronic Ear aimed at conditioning the audio-phonatory system.
3. If for some reason it is not wished to interrupt the language study, then ten minutes or a quarter of an hour of each lesson should be devoted to purely phonetic exercises with the Electronic Ear.
4. However long the Electronic Ear is used for, its essential purpose must be the progressive and methodical assimilation of all the specific sounds, rhythms and intonations of the language studied, that is to say the elements in the speech chain which the student of another nationality finds most difficult to acquire. Its effectiveness will depend on the extent to which the programme and the progression are adapted to the special needs of each student, with the help of a previous audio-vocal test which will be described later.
5. If the phonetic exercises with the apparatus are to prepare effectively for the actual study of the language, the groups of sounds chosen for the exercises can constitute the essential basis for the first stages of learning. Even if the student does not understand them and regards their repetition merely as a phonetic exercise, he will nevertheless be placed in the position of a very young child who, while progressively acquiring the sounds and behaviour of his mother tongue, gradually establishes in his reflex the meaning and the use of groups of sounds, the phonemes or semantemes which he hears around him.

It would therefore be useful to use, along with the phonetic exercises, synchronised slides or still pictures to give an initial idea of the more or less exact meaning.

6. Although generally a single repetition of groups of sounds is sufficient, the teacher or supervisor should nevertheless ask the student to make the effort to repeat each group, several times if necessary, until he has acquired an intelligible and, if possible, perfect pronunciation, corresponding to a high level of audio-vocal conditioning.
7. As the student, thanks to the Electronic Ear, hears his own voice perfectly, the use of a double-track recorder allowing self-checking is particularly recommended.
8. Finally, we must mention the absolute necessity of using equipment with characteristics complying with high quality standards. Any defective element in the chain of the system may not only spoil the transmission of the message the student is to hear, but also its assimilation, which can be made more difficult according to the extent to which the alteration taking place in passage changes its original composition.

What, then, are the precautions to take and the main faults to avoid ?

The latter can arise in any of the parts of the system. The recording must also be of excellent quality. The periods left for repetition, called the "sound blanks", should be carefully spaced out. The recorders should reproduce faithfully the contents of the tape, with no distortion. The linearity which should be insisted on is absolutely necessary up to 12,000 Hz (for English, for example). We have often been shown whole laboratories fallen into a state of neglect and wearying the students because the tape recorders, with response curves which differ one from another, were introducing distortion which made the original sound signal unrecognizable.

If the student is required, when listening, to correct or try to grasp with difficulty the sound message that is being transmitted to him, it then becomes impossible for him to achieve the desired assimilation. The unfortunate use of bargain machines has brought into existence in this field a mountain of potentially disastrous toys. We have in fact seen (Chapter III) the flexibility of an auditory pattern which can model itself on the curve imposed on it and on the message which is passed to the auditory zone. It can therefore be seen that equipment with a curve that cuts off at 3 or 4,000 Hz can engender auditory conditioning quite contrary to that required.

We have even checked recorders - to be used for educating the ear - in which everything starts to fade out at 500 or even 300 Hz. The standards currently used, allowing a drop above 5,000 Hz, can only be justified on commercial grounds, but they give no safeguard and remain ineffective.

Without wishing to dwell at length on these technical points, we should however make it clear that in the audio-visual field the "near enough" as far as equipment is concerned inevitably leads to total failure.

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In addition, we must stress the fact that the student should actively participate in his linguistic initiation by his own determination and effort.

Though it is now shown that the benefits of current teaching methods have been increased tenfold by the use of the Electronic Ear, it remains no less true that once the hearing/speech system has been conditioned, the grammar and the vocabulary of the language still have to be learned.

Therefore the effort the student must make should not be minimised. However, it should also be stated that his motivation, which is undoubtedly a major factor, is much enhanced by the removal of the initial inhibitions stemming from the unintelligibility of the spoken language and the consequent impossibility of reproducing it.

The audio-visual techniques the principles of which we have just discussed should in this way - and this will be the conclusion of this chapter - be able to render a major service to the teacher by allowing his students to open their ears perfectly to the instruction which is lavished on them. It is then no longer a question of a dialogue of the deaf but of a fruitful exchange between individuals able to communicate through the medium of one language correctly transmitted.

The teacher, relieved of an onerous task, is now able to pass on to his students all the subtleties, all the specific elements of the language for which he is the "spokesman". Against a perfectly conditioned background he can easily convey the culture and psychology of the ethnic group it represents.

As we noted at the beginning of this chapter, we do not intend to

present these techniques as a complete answer. They must certainly remain as instruments to be used in teaching, but they constitute an indispensable aid to the teacher of modern languages.

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## VI.

## AUDIO-VOCAL TESTS

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The fundamental laws of Tomatis and their corollaries studied above give rise to the need for an exact knowledge of the auditory capabilities of anyone who wishes to study a foreign language.

This measurement of hearing can be easily carried out by means of a battery of tests which directly cover the auditory faculties of the subject and, at the same time, indirectly, by counter-reaction based on the principle of the Tomatis Effect, his vocal capability.

Two kinds of examination may be distinguished :

### 1. - LISTENING TEST -

This is carried out by means of a device called a Psycho-hearing Instrument. This comprises a set of sound sources, a kind of electronic tuning fork, with frequencies which are pure, stable, without harmonics and of a measurable intensity.

The sounds emitted by the P.H.I. run from 125 Hz (1) to 8,000 Hz, octave by octave. Each of the frequencies can be produced at a variable intensity between - 10 dB and +100 dB (2) in 5 dB steps.

The test is carried out with the aid of a headset and a vibrator. The subject is made to hear each frequency in succession and his auditory acuteness limit for each is noted. In this way four curves are obtained, two for each ear (air conduction and bone conduction).

The P.H.I. measurements of the listening test thus made enable a curve of limits to be obtained, that is to say of limit minima or, rather, the minimum audible limits. This is called "preliminary listening test". It was the first to be used, its simplicity and the fact that it gives absolute results enabling comparative studies to be made.

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(1) Hz - Hertz - cycles/second, a unit of frequency.

(2) dB - decibels, a unit of intensity.

When an audiogram has thus been obtained which indicates the subject's auditory sensitivity to pure frequencies, a study of auditory selectivity is then made. The object of this test is to find out the zones, the ranges, within which the subject is able to make a perfect analysis of the sounds received. In this way it is possible to find out whether he is more sensitive to low notes, notes in the middle range or high notes, or to the whole range of frequencies.

After the selectivity testing, the third test is the spatialisation test. It consist of establishing from which side (right or left) sounds arrive by bone conduction. It often happens, with subjects having poor spatialisation, that some frequencies emitted on the right are heard on the left and vice versa. The errors at each frequency are then noted on the listening test. The results obtained show the "stereophonic" capacity of the person being tested.

Finally, a study of auditory laterality with the aid of a specially designed piece of apparatus (an audio-laterometer) enables the leading ear of the subject to be determined, this being the ear which controls verbal output.

From the results obtained from these various hearing tests, the subject's predisposition to one or more languages can be assessed.

## 2. - VOCAL TEST

This completes the measurement of the subject's auditory capability. Following the principle of audio-vocal counter-reaction (Tomatis Effect), analysis of the voice indicates precisely the way of hearing.

To a practised ear, listening to the spoken voice can already give some valuable indications which can then be confirmed by instrumental analysis. The examiner can assess the timbre of the voice, the intensity, the modulation and the facial laterality (by noting whether the subjects speaks to the right or to the left), the factors which indicate the acoustic analysis capacity of the subject being tested. A voice with good timbre, for example, emitted at adequate intensity and using the right-hand side, suggests a high capability of analysis and language control.

As mentioned above, this first assessment of the voice may be carried further by instrumental examination using panoramic analysers and sonographs or with the aid of a new piece of apparatus called a "phono-integrator". With this the recorded voice of the subject is broken down by various different processes enabling separate assessment to be made of the various characteristics in terms of frequency, intensity and duration, and thus obtaining the spectral characteristics of the voice - which correspond, let us remember, to those of the subject's hearing.

The latter research is really only done in the laboratory. Simpler tests have been devised, such as those using a P.H.I., which provide an exact assessment of an individual's auditory assimilation capability so far as foreign language learning is concerned.

We would stress the value of these tests which help to avoid unfortunate errors in vocational guidance and consequent waste of time, as much for children as for adults.

In our opinion these audio-vocal tests should be applied systematically before any study of a modern language. They would prevent a potential language student from having the misfortune to involve himself in studying a language which he has no aptitude for hearing, that is to say for assimilating.

Actually, with the help of the Tomatis Effect Electronic Ear, most of these difficulties disappear. In effect, not hearing a language means not having the range of the language to be assimilated. The Electronic Ear, by a process of auditory preparation, causes a modification of the curve, an enlargement of the range, and thus enables the pupil to assume one auditory posture or another which induces, ipso facto, the appropriate posture of the whole bucco-pharyngeal system.

The audio-vocal test serves to indicate how the child should be conditioned so that the chosen language is then accessible to him.

In the case of selectivity, spatialisation or lateralisation defects, preliminary treatment with the Electronic Ear should be envisaged so as to overcome the initial defect. Repetition exercises, engendering also a deep-seated and lasting modification of the subject's way of hearing, will cure his initial auditory maladjustment.

The ease that this brings to language study is further aided by perception of the slightest phonetic nuances of the language and ensures greater perfecting of the accent.

Repeating the audiometry at regular intervals enables the subject to measure his progress objectively and allows the instructor to correct the adjustment of the apparatus until an auditory curve giving perfect pronunciation is obtained.

The use of audiometry to guide foreign language study is one of the most spectacular and - it should be said - unexpected practical applications of the Tomatis Effect. It is only now that we have come to appreciate the extent to

which auditory measurement is necessary before language study, in the same way as a vision test before flying an aircraft.

We may therefore hope that educational guidance - the necessity for or benefits of which no-one nowadays would think of questioning - will take into consideration the importance of subjecting all our schoolchildren to audio-vocal tests before the study of any foreign language.

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## CONCLUSION

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Having reached the end of this report - or, rather this "exposition" - of studies relating to the Tomatis Effect and its applications to the field of linguistic assimilation, our most earnest hope is that the reader who has followed our text to the end is deeply convinced that to hear and to hear well is the central factor in language problems and in particular in this case in the study of foreign languages (1). We think we have stressed this point enough not to have to return to it.

Anyway, we would like to end these pages on a hopeful note. It is not long since one could write, in speaking of the ease with which young children learn foreign languages : "This wonderful aptitude decreases fairly rapidly at about the tenth year and most educationalists and psychiatrists agree that, from the age of fourteen, true bilingualism is impossible" (2) . The Tomatis Effect now enables us to push back this limit of possibility.

Therefore, today, it is no longer out of the question for an adult to dream of learning a language other than his own to the point of assimilating it as if it were his mother tongue. This statement, which is based on theories which have been scientifically established and verified by lengthy experiment shows the essential rôle played by hearing in language study. By modifying a subject's hearing, as we have repeatedly stated throughout this work, and imposing on him the typical "ethnic" curve of the language chosen for study, one ensures at the same time the assimilation of that language.

If one realises - and who nowadays does not - that behind the words of a foreign language there lies a whole thought process, a whole range of psycho-philosophical concepts, that can only be acquired by mastery of that other language, then it follows that rather than the mere study of a language, it is a whole sound universe and a new psychology which we are inviting our readers to enter.

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(1) We are happy to note, in a recent doctorate thesis, a corroboration of what might appear to be the leit-motiv of this brochure. See André Jacob. Time and Language. Paris 1967 A. Colin pp 158-256 and seq.

(2) In : International Languages - "Que sais-je" publications No. 968.

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