

THE EFFECT OF AUDIO-PSYCHO-PHONOLOGY
ON STUTTERING

L'action de l'audio-psycho-phonologie sur le bégaiement

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1. INTRODUCTION

A general survey of current literature on stuttering indicates that in spite of their precision and thoroughness, extensive experimental investigations have contributed proportionately little towards providing a clear, concise and generally acceptable outline of the problem of stuttering. Contradicting and conflicting results from numerous carefully controlled empirical investigations toward an etiology of stuttering, have left many a speech therapist and clinical psychologist concerned with an effective therapeutic technique for the stuttering problem, in a state of confusion and frustration. It is not strange to hear an expert in speech pathology concluding: "We do not know how stuttering originates".

Notwithstanding this confusion, two aspects are constantly emphasized by investigators:

- 1) the function of hearing as the initiator of the speech act, and
- 2) the reciprocal interaction between the mother and the child in speech acquisition.

These two factors also form the core around which Tomatis's theory and his therapeutic technique of Audio-psycho-phonology has developed,

Tomatis defines stuttering in the context of a developmental problem. He regards stuttering as a fixation on the bisyllabic phase of speech development - thus a chronic continuation of the natural "stuttering" of the small child, in such a way that his speech always seems to be a "song to the mother" (Tomatis, 1973). This implies an inability to bridge the mental gap between the two polar components of mother and father, which, in normal development, should be introjected in the psyche of the child as a functional unity. Eventually an unconscious monologue as if the child were attached to the mother alone (Tomatis, 1972, p. 155), dominates the child's communicative processes and reinforces the stuttering syndrome in such a way that all characteristics symbolized by the maternal polar component (e.g. the left, the past, the primary somatic drives, the egotistic nature) develops primary to those symbolized by the father (e. g. the right, the future, the psychic and spiritual drives, the altruistic nature).

Secondly, Tomatis hypothesizes, and in fact has demonstrated empirically (Tomatis, 1957 a), that the hearing function as the initiator of the speech act, not only perceives the pressure of sound waves, but also analyses the incoming stimulus within limits of diverse dimensions: it discerns the loudness, the pitch, the timbre and the rhythm. In man, the auditory input is not accepted at its face value alone; the ear is not a passive receptor, but it analyses and transforms the input by means of subtle internal variances into a mental process.

Characteristically, the dynamic organisation of the stutterer's listening process is revealed in the hearing test as a relative hypofunction within the speech-area of the leading ear (Tomatis, 1954 a).

Audio-Psycho-Phonology has been defined as the study of the various incidences existing between man's "Aural posture" and his psychological and phonatory attitudes. The Electronic Ear has been described as an apparatus devised with the therapeutic aim of providing a corrective feedback into the Audio-psycho-phonological speech chain, which might have been disrupted by traumatising factors mentioned previously.

The purpose of the study carried out in the Department of Psychology at Potchefstroom University, was to investigate the assumptions outlined above by means of a theoretical and an experimental investigation. Although the primary aim of this paper is to report on the experimental investigation, some theoretical considerations deserve attention beforehand.

2. THE PARENT-CHILD RELATIONSHIP AS DETERMINANT FOR STUTTERING

2.1. The speech development of the child is presented by Tomatis as a dynamic parent-child interaction through the phonic phase towards the syllabic and the linguistic phases of speech development (Tomatis, 1972, 6, pp. 56-66). The first period is characterised as a period of audio-vocal exercise with special refinement with in the mother-child feedback; the second period (syllabic) is described as natural stuttering, because of the bisyllabic character of speech which is still primarily being directed towards the mother; the third period forms a bridge to social speech and requires communication with the father, the "other" and the social environment.

Tomatis's consideration that stuttering may represent a chronic continuation of the natural "stuttering" finds support from various investigations. The critical role of the mother-child relationship in speech development has been demonstrated by numerous studies, e.g. those conducted on children reared in orphanages (Bowlby, 1951). Baker (1955) regards "reciprocal identification" between speech partners as the central mechanism of all speech relations. A withdrawal of the mother in the reciprocal identification stage, at an instant when the child is still immature and unprepared, may leave him in a state of acute and intense frustration.

Wyatt (1969) applied this line of thought in her "development crisis theory of stuttering". She found that stutterers as a group experience intense fear of being separated from their mothers, significantly more often than a group of non-stutterers. Stutterers also seemed to have a more intense need for the presence of their mothers. The stuttering child seems to be the victim of a perpetual problem: the fear of separation gives rise to heightened feelings of rage and hostility directed against the mother and the aggressive feelings then generate in the stutterer a fear of separation as a means of retaliation by the mother. Wyatt concluded that disruption of the mother-child relationship during a critical developmental period of the child, might lead to compulsive repetitions and a fixation at this period. Tomatis's refreshing re-interpretation of the Oedipal myth (Tomatis, 1972, P. 111), has underlined such a critical developmental phase.

2.2. Tomatis's very inspiring outline on "verticality, laterality and speech" (Tomatis, 1963) is well known and needs no further comment, except the following:

- The rich symbolism of the polarities left and right, mother and father, etc. as presented by Tomatis, are confirmed in relevant literature by various investigators, e.g. Ornstein (1972), Damhof (1969), Fagan and Shepard (1971).
- As in speech and laterality, man distinguishes himself from all living creatures by his vertical body posture. Through his verticality man is elevated in such a way that his sensations become truly human perceptions. This, however, requires the maintenance of an equilibrium between the vertical force and the gravity of the earth. The mastering of this balance may take years, since man seems to be subjected to the force of gravity throughout his life. The child's maintenance of this unique and essential human characteristic of verticality seems also to be a qualification for his development. In the same way as his feet need a firm support on mother earth for a vertical body posture, man's independence and ultimate maturity also develop from the security of a firm relationship with the mother, characterized by an empathetic bond, and a freedom of growth to the other polar components: the father, the social environment, the spiritual and higher developmental levels.

On the social-psychological Level, the attainment of an effective equilibrium between these polar components left and right, mother and father, soma and psyche, past and future, etc., seems to be an inherent necessity to human development, the attainment of which is a primary goal in present-day psychotherapies.

2.3. Tomatis's quest for a therapeutic effective technique in establishing this equilibrium, has brought him to the assumption of prenatal rhythmic-acoustic engraving (Tomatis, 1972 b, p. 21) and the application of filtered mother's voice. The latter seems to be a unique and original APP-technique, found in no other therapy, notwithstanding substantial support for prenatal rhythmic-acoustic engraving. Ormerod (1960), Johnson, Wederberg and Westin (1964), Grosser and Ortman (1966), Clauser (1971) are a few who confirm Tomatis's assumption of a very early functioning ability of the ear during the prenatal period. Also Salk's experiments in the City Hospital, Elmhorst N.Y., serve as a well-documented indication of prenatal rhythmic-acoustic engraving. (Salk, 1960, 1961, 1962).

Tomatis's technique of filtered mother's voice is aimed at the dispelling of anxiety and establishing feelings of security (Vide: Sarkisoff, 1973). Clinical observations confirm a very early recognition of the mother's voice by the infant, as well as positive reactions to filtered mother's voice in the anxious, insecure or aggressive child.

It was concluded that on the basis of anatomic-physiological considerations, as well as experimental confirmation, prenatal stato-acoustic engravings are not only possible, but may be significant to postnatal learning.

3. THE HEARING FUNCTION AS DETERMINANT FOR STUTTERING

Tomatis's diagnostic techniques and therapeutic applications emphasize that it is the experiencing corporality which is pregnant with psychological meaning. Language subjects man to a very subtle bodily experience on the one hand, but also forms the springboard he needs to make the jump into higher dimensions "where Word-Thought can exist unsupported beyond the gravitational pull, the spoken word exerts towards the world of matter" (Tomatis, 1969, p, 14). For this, man is equipped with the ability to

listen, i.e. to hear with devotion, concentration and integration. This ability enables man to achieve humanness which subserves language.

Tomatis thus couples the most far-reaching implications to the hearing function with in its broadest context as determinant for language. He has not only demonstrated a parallelism between the auditory input and the phonatory output (Tomatis, 1956), but has also documented idiosyncrasies of the auditory organisation typical to the stutterer (Tomatis, 1954 a). Above all, he has provided a method of auditory training for the traumatised ear, firmly based on a theory. This needs further consideration.

Language can be described as a cybernetic system. Phonation is controlled by audition. The sensory input is individually selected, digested, stored and transformed by internal forces. The output (speech behaviour) is continuously being monitored by feedback processes and reported back by a central regulating mechanism. (Vide: Wiener, 1954). This model may be applied to different functioning levels relevant to stuttering behaviour.

On the psycho-social level, Mead's model is applicable. He demonstrated that in his interaction with his environment, man is continuously testing reality in a highly selective way. Perception is organised in terms of hypotheses, which after manipulation, lead to meanings, with the result that behaviour is inhibited or facilitated respectively by negative or positive feedback. (Shibutani, 1969, p. 330). Wyatt's developmental crisis model, previously quoted, applies this principle to the problem of stuttering: disruption of the reciprocal identification between mother and child during a critical developmental phase, may lead to compulsive repetitions. When the disruption reaches the emotional level, positive feedback and behaviour pathology result.

For the application of the feedback principle on the organistic level, the research of Berry (1969, p. 29), Brazier (1964), Galambos (1956, p. 424), Fairbanks (1954, p. 133) may be quoted. These investigations demonstrate clearly that self-regulating servo-mechanisms function with in the nervous system as a very refined and complicated impulse-conduction system, imparting precision to the selective control of the ear in phonation and vice-versa.

On the physical-acoustic level, the following deductions were made from the extensive research quoted in the relevant literature:

- i) Within the speech-hearing feedback circle of the stutterer, a delay which disrupts the speech act is highly probable (Fairbanks, 1955; Stromsta, 1958; Berry, 1969; Cherry and Sayers, 1956; etc ...).
- ii) This disruption is probably active in the feedback systems of all modalities which serve language (e. g. auditive, visual, tactile - kinaesthetic and proprioception), but these are of secondary importance to the ear within its archeo-, paleo- and neo-developmental stages and functions as described by Tomatis (1974, 1974 6, P. 49). Traumas may act as fore runners and precipitators to disruptions. They may even remain as memory traces within the nervous system and reappear in states of neurological dissolution or psychological regression, as clinical observations have demonstrated time and time again.
- iii) Within the framework of auditory feedback, a relation seems to exist between bone conduction feedback and stuttering, but more important, between the low

frequencies and stuttering (Cherry and Sayers, 1956 ; Stromsta, 1958 ; Ham and Steer, 1967 ; Bachrach, 1964).

These findings suggest substantial support to Tomatis's therapeutic approach of auditory re-education through high-frequency stimulation as a therapeutic aid to stuttering.

Auditory training by means of the Electronic Ear, implies that the middle ear muscles may be conditioned to a state of adaptation to the sound environment. On the basis of various studies quoted (Kosteljik, 1950; Wersall, 1958; Reger, 1960; Moller, 1972) it has been fairly well established that upon contraction of the tympanic muscles, the physical properties of the conduction system of the middle ear are changed: a reduction in the sensitivity for low-frequency tones and an improvement of tones above 1,000 c.p.s. give rise to an ascending audiometric curve. Years before these findings, Tomatis described such an audiometric curve as the graphic representation of a well-adapted ear.

Auditory re-education also finds supports in the accomodation theory which regards the contractile action of the tympanic muscles as a mechanism designed to adjust the sound-conducting apparatus to the best possible absorption of sound energy. This theory has arisen in analogy with the process of accomodation in the eye, presupposing that the individual, by an effort of will, or unconsciously, selects and follows certain sounds. The theory assumes co- operation between the two tympanic muscles in such a manner that they, in their capacity as morphological and functional antagonists, should be able to bring about a fine adjustment of the ossicular chain.

This theory explains Tomatis's assumption of selective hearing as a reaction to emotional stimuli.

Speculation about the sensory modality most important for speech perception as revealed in the relevant literature, gives the impression of a compartmental view of man. Since the human body is not an agglomeration of organs, but an organism, so human actions reflect the human being in this organismic totality. Tomatis 's explanation of the development of the ear through its pre-, archeo-, paleo- and neo-developmental stages, his observations on the neurological and dynamic inter-actions between hearing, visuo-motor control and proprioception within the functional unity of the speech act, his diagnostic techniques and therapeutic applications, not only emphasise a holistic point of view, but have also provided very important insight into, as well as a major contribution towards, a psychology of hearing.

4. EXPERIMENTAL INVESTIGATION

4.1. Aim

The primary aim of the study was to apply the technique of Audio-Psychophonology to a group of stutterers and to evaluate the outcome by means of various measures.

4.2. Subjects

The experimental investigation was conducted on a group of 30 young adult stutterers (22 males and 8 females), with an average age of 21 years and a mean I.Q. of 112. All of them received auditory training with the aid of the Electronic Ear.

4.3. Tests and procedure

The selection of the tests was influenced by the primary aim of the study, i.e. the effect of auditory training on the speech behaviour of secondary stutterers. Since Audio-Psycho-Phonology is specially interested in the internal organisation of the auditory input, as well as the physio-acoustic characteristics of the vocal output, the hearing test and a spectral analysis of the subjects' phonatory output were also part of the testing program.

The following tests were administered before auditory training had begun and again after the training was completed:

- i) The Lanyon Stuttering Severity Scale (Lanyon, 1967) for an indication of the severity of the stuttering symptoms.
- ii) An analysis of speech and reading samples according to Johnson's method for estimating the amount of disfluencies (Johnson et. al., 1963).
- iii) Johnson's measures of rate of speaking and oral reading (Op. cit.).
- iv) The Iowa Scale of Attitudes toward stuttering as an assessment of the speaker's feelings about his own speech and about stuttering in general.
- v) An audiometric investigation to evaluate the effect of auditory training on hearing acuity.
- vi) A speech spectral analysis of the reading voice to evaluate the effect of auditory re-education on the physical-acoustic aspects of phonation.

The statistical design for the interpretation of the results was primarily directed towards testing the significance of the difference between the two means. In this model the experimental group was used as its own control. For evaluation of the difference between the means, the t-test for correlated samples was applied.

4.4. Results

4.4.1. Severity of stuttering symptoms

As Table 1 indicates, a mean value of 71.50 % was attained on the Lanyon SS Scale before re-education, which is an indication of a severe stuttering problem. After auditory training the mean value of 41.76 % represented a mild stuttering problem, and a significant difference on the 1 % level of confidence was attained.

Table 1 - Evaluation of the difference of means on the Lanyon Scale for 30 stutterers.

Mean values		Difference	s	t	p
Before	After				
71,50	41,76	29,74	15,40	10,57	0,01

4.4.2. Measure of disfluency in speaking and oral reading

This measure requires a representative sample of speaking and oral reading for each subject, which has been obtained by means of the Job Task and TAT Task as subjected by Johnson et. al. (1963, p. 204).

A verbatim transcription was made and all disfluencies identified and classified into the following categories:

- interjections; post-word repetitions; word repetitions; phrase repetitions; revisions, incomplete phrases; broken words; prolonged sounds.

This method provides for the computation of the number of each of eight types of disfluency per 100 words, as well as a Repetition Index and a Total Disfluency Index.

For the purpose of this paper, only the total Disfluency Index will be presented.

Table 2 - Evaluation of the difference of means of the total disfluency index, before and after auditory training for 30 stutterers.

	Reading					Speech				
	Before	After	Dif.	s	t	Before	After	Dif.	s	t
Total disfluency Index	16,35	6,20	10,15	9,48	** 5,84	26,55	11,90	14,65	12,11	** 6,5

** Significant at the 1 % Level.

As Table 2 indicates, highly significant differences were found between the average amount of total disfluencies before and after auditory training, both for oral reading and speech.

4.4.3. Measuring the rate of speaking and oral reading.

Investigators of stuttering behaviour noted the generally inhibitory quality and the reduced rate of utterances which tend to be characteristic of it. In general, the relevant data indicate that expectation of stuttering is characterized by apprehensiveness and is integrally related to the stutterer's speech behaviour, contributing heavily to its inhibitory quality. A major implication is that severity of stuttering is, in part, a function of the inhibitory or avoidant behaviour represented by a depressed rate of utterance. It follows that speech improvement for the stutterer is to be sought through increased spontaneity, expressiveness, communicative desire and a growing willingness to speak.

In order to estimate the effect of auditory training on the rate of speaking and oral reading, Johnson's measures were applied (Johnson et. al., 1963). The results of the overall rate in words per minute appear in Table 3.

Table 3 - Evaluation of the difference of means of rate of oral reading and speaking in W. P. M. before and after auditory training.

Over-all rate in w.p.n.	Mean value s compared		Dif.	s	t	p
	Before	After				
Reading	99,1	117,5	18,4	24,5	4,13	0,01
Speaking	88,2	111,5	23,3	21,3	5,98	0,01

As indicated in Table 3, a significant faster rate for both oral reading and speaking was attained after auditory reading.

4.4.4. Attitude towards stuttering

A further part of the evaluation of the effect of auditory training on stuttering behaviour, is an assessment of the speaker's feelings about his own speech and about stuttering and stutterers in general. The Iowa Scale of Attitude Toward Stuttering (Ammons and Johnson, 1944) is designed to be used in this connection. The scale consists of 45 statements about stutterers and what they should or should not do or feel in various speaking situations. The numerical score yielded by the scale, is intended to throw some light on the subject's attitude toward stuttering, especially his tolerance or intolerance of stuttering. In Table 4 the mean scores are represented.

Table 4 - Evaluation of the difference of means between attitude towards stuttering before and after training.

Mean values compared		Dif.	s	t	p
Before	After				
2,46	1,65	0,81	0,62	7,15	0,01

The results in Table 4 suggest that the subjects reflect a significantly more healthy attitude toward the problem of stuttering, after they have received auditory re-education. Because of the relative ease for the subjects to make responses that "look good", the effect of the social desirability tendency should not be overlooked in the interpretation.

4.4.5. The hearing test

The audiometric examination was considered as an important aspect in this investigation, because Tomatis observed a general tendency of a relative hypofunction in the middle frequency range - especially noticeable in the leading ear of the stutterer. He further postulates that auditory training with the aid of the Electronic Ear may rectify this tendency which may lead to greater speech fluency.

The mean acuity scores for air and bone conduction of both the right and the left ears, before and after auditory training, appear in Figure 1 and Figure 2 while an evaluation of the difference of means is presented in Table 5.

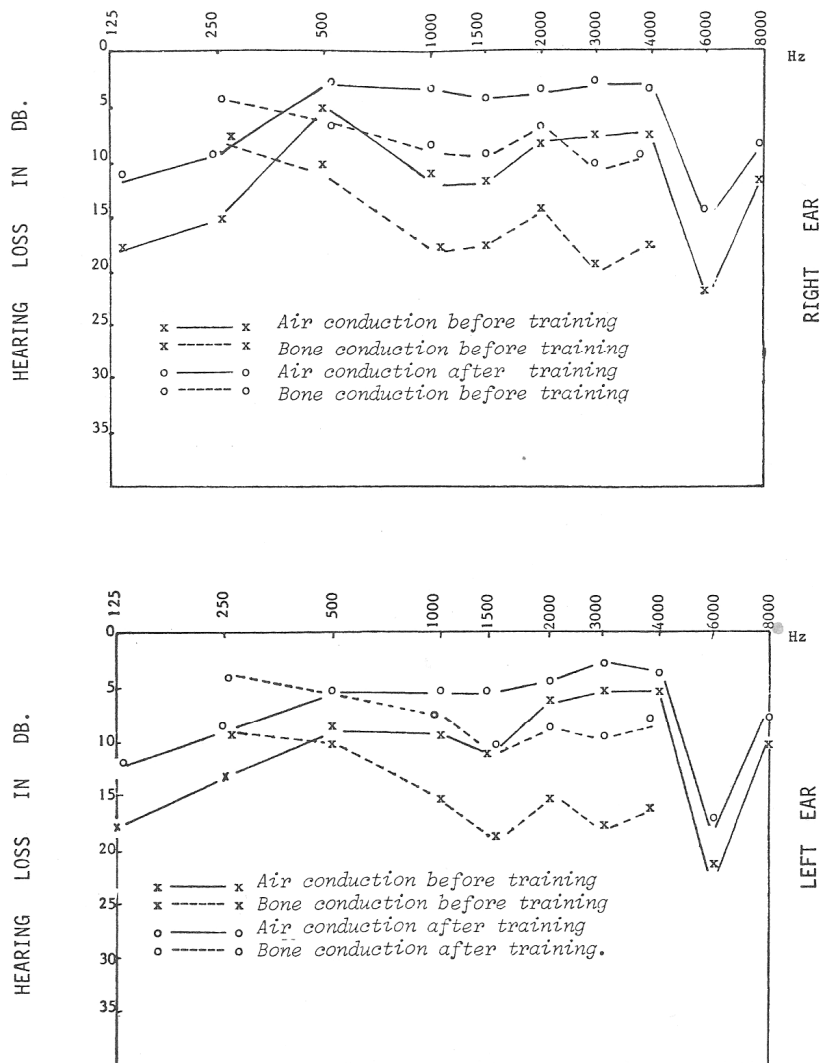


Table 5 - Evaluation of the differences of means between hearing loss before and hearing loss after auditory training. n = 30.

Frequency in hertz	Mean values compared		Dif.	s	t	p
	Before	After				
Right Ear						
a) Air conduction						
125- 500	12,94	8,10	4,84	3,74	7,07	0,01
1000-2000	10,77	4,22	6,55	6,18	5,80	0,01
3000-8000	12,54	7,83	4,71	6,46	4,62	0,01
b) Bone conduc- tion						
250- 500	9,91	5,25	4,66	7,50	3,34	0,01
1000-2000	16,94	8,66	8,28	10,94	4,14	0,01
3000-4000	19,0	10,33	8,67	10,65	4,41	0,01
Left Ear						
a) Air conduction						
125- 500	13,61	9,05	4,56	5,12	4,87	0,01
1000-2000	8,94	5,22	3,72	3,67	5,56	0,01
3000-8000	11,14	8,16	2,98	4,16	4,0	0,01
b) Bone conduc- tion						
250- 500	9,50	4,83	4,67	7,43	2,94	0,01
1000-2000	16,44	9,0	7,44	8,60	4,79	0,01
3000-4000	17,16	9,25	7,91	8,23	5,37	0,07

From a comparison of the values presented in Table 5 and inspection of the curves in Figures 1 and 2, it is evident that a relative hearing loss appears in the middle frequency range (speech area) of all the curves (before auditory training). These findings seem in line with Tomatis's findings.

The difference of means between the acuity scores between the low, middle and high frequency ranges before and after re-education have been tested for significance (Table 5) and from the results obtained, it is clear that a significant gain in hearing acuity has been obtained after auditory re-education.

4.4.6. Spectral analysis of reading samples

For the spectral analysis, a technique designed in collaboration with the Electronics Division at Potchefstroom University is described in the study. This method uses a tape loop to analyse a speech sample with a duration of 20 seconds at a recording speed of 19 cm , This method made it possible to integrate the energy for each one-third octave frequency band and present the product graphically with the aid of a Bruel & Kjaer Level Recorder. Reliability tests revealed an error of measurement smaller than 0,5 db. The measure therefore could be used with confidence.

The distribution of the mean values of the spectral energy is presented in Figure 3 and an evaluation of the differences of means for the low and high frequency zones appears in Table 6.

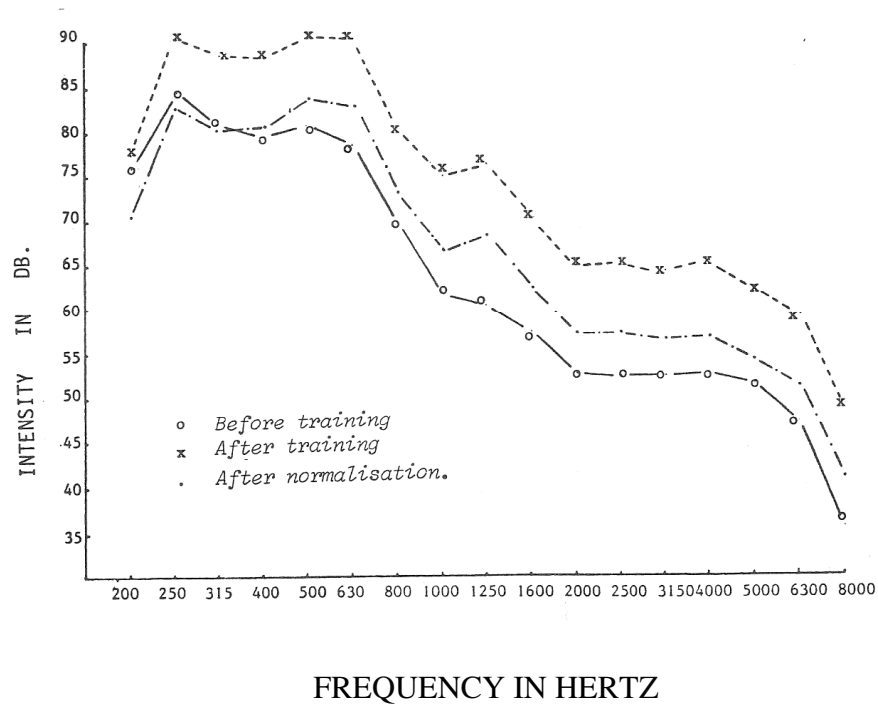


Figure 3 - Distribution of the mean values of the spectral energy for 24 reading samples.

Table 6- Evaluation of the difference of means in DB of spectral energy for the low, medium and high frequency zones of reading samples for 24 stutterers before and after auditory training.

Spectral range	Mean values compared		Dif.	s	t	p
	Before	After				
200-500 hz	84,56	91,09	6,53	6,48	4,93	0,01
630-2000 hz	72,46	84,10	11,64	8,53	6,68	0,01
2500-8000 hz	53,57	65,48	11,91	6,74	8,64	0,01
Total energy	100	107,91	7,91	9,74	3,99	0,01

For a better comparison of the forms of the spectra in Figure 3, it seems advisable that the total energy in the two samples should be normalised. These transformations are also graphically represented in Figure 3.

Inspection of the curves in Figure 3 shows that the gain in spectral energy after auditory training, is noticeable within the full range of the spectrum, but especially evident within the middle frequencies. The figures in Table 6 also suggest a significant gain in spectral energy within all three frequency zones.

4.5. CONCLUSIONS

1. The severity of stuttering, as measured by the participants' attitude towards their speech problem, was significantly less after auditory training. The effect of the social desirability tendency was considered as a possible contributing factor. When placed in the context of the larger testing programme, however, the results favour an interpretation of greater freedom of expression as a result of the re-education programme.
2. Participants performed significantly better with regard to the number of speech disfluencies in a representative speech and reading sample. The conclusion was drawn that auditory training was the most important variable responsible for this change in speech behaviour.
3. A significantly faster rate of speech and oral reading was registered after completion of the re-education programme. Since the relevant research data generally confirms that severity of stuttering is, in part, a function of the inhibitory or avoidant behaviour represented by depressed rate of utterance, the faster rate of utterance registered after auditory training was ascribed to speech improvement.
4. The significantly lower scores attained after the training programme by the "Iowa Scale of Attitude towards Stuttering", indicate a better attitude toward stuttering and considerable tolerance of stuttering. Because these results are supported by the data of the other tests it was concluded that the training programme should receive more consideration as the responsible factor for the better attitude, than other possible by-factors.
5. The audiometric examination was considered as an important aspect in this investigation, because Tomatis observed certain auditory characteristics which could not be verified in the literature on stuttering. The results supported Tomatis's observations with regard to the following:
 - i) The mean acuity-scores reveal that the stutterers as a group show a hearing loss in the frequency range of the speech area. This seems especially prominent in the speech area of the right ear, as Tomatis predicted.
 - ii) Significantly better acuity scores were registered after re-education in the low, middle and high-frequency zones, but were especially prominent in the middle frequencies, i.e. the speech area.
 - iii) Audio-vocal conditioning was found to be the only responsible factor for the better acuity scores and accompanying decrease in speech disfluency.
6. A spectral analysis performed on the oral reading samples also supports Tomatis's observations. An evaluation of the mean values of the low, middle and high frequency zones, showed a significant gain in energy in the vocal output of the group, after audio-vocal training. As revealed in the mean values

of the audiogram, the gain in spectral energy again seems most prominent in the frequency range of the speech area.

The general conclusion to be drawn from this investigation is that auditory re-education or audio-vocal training with the aid of the Electronic Ear as defined by Tomatis may lead to

- i) an improvement of hearing behaviour,
- ii) a corresponding modification of the physical-acoustic and temporal-rhythmic characteristics of speech, which ,
- iii) give rise to greater speech fluency.

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