PITCH LEARNING AND THE IMPLICATIONS FOR MUSIC EDUCATION

by

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CONTENTS

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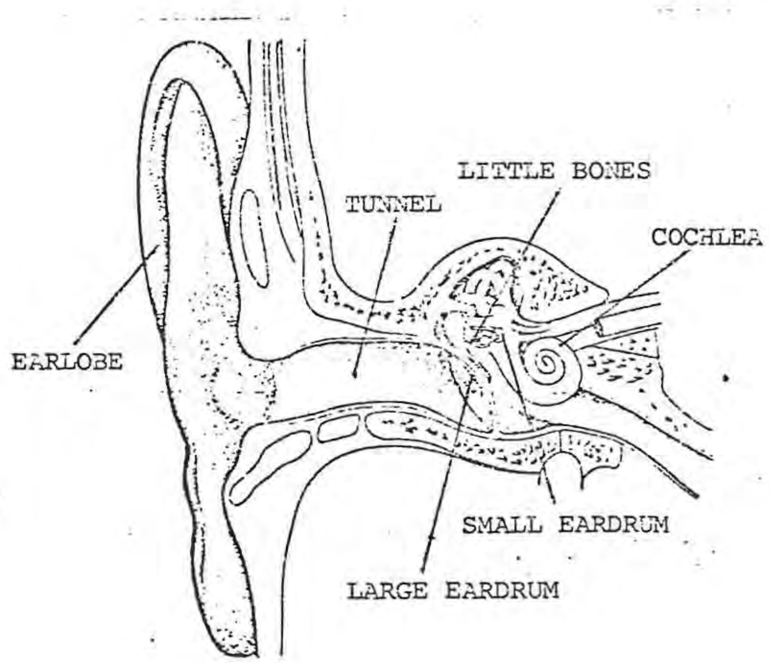
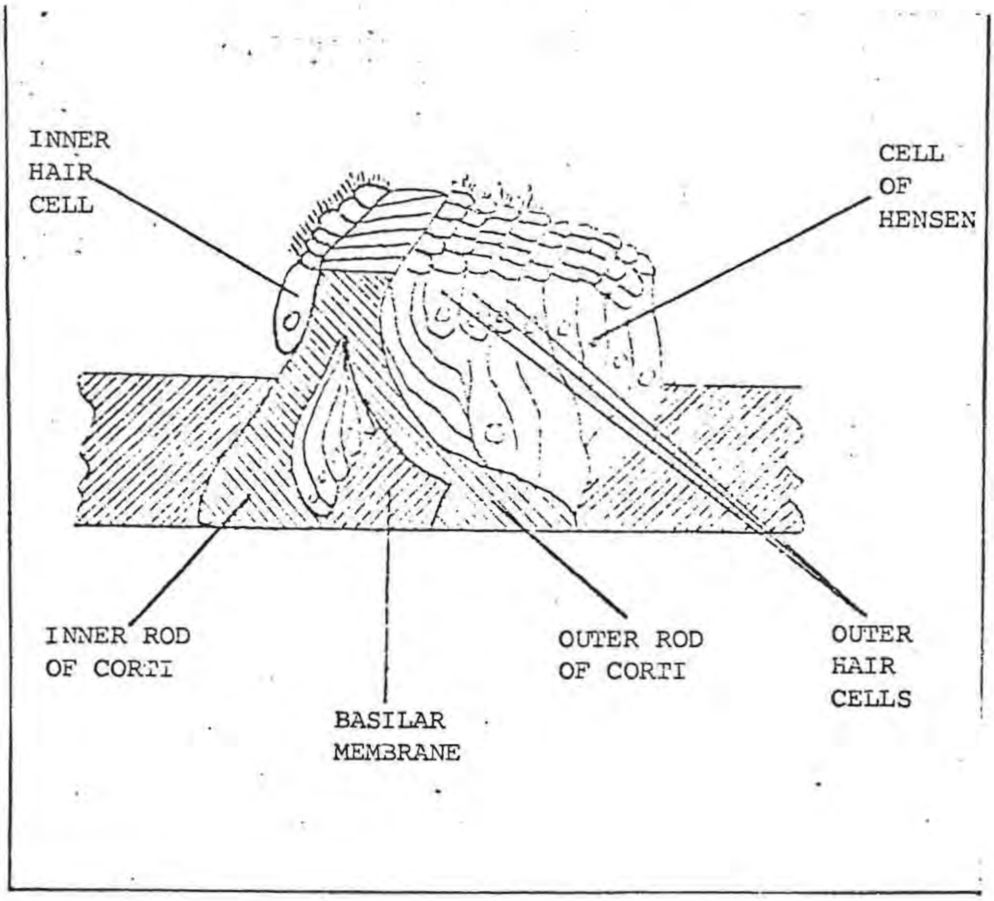
INTRODUCTION

A study of pitch learning must outline first the procedures involved in such learning and then identify specific factors appearing to influence the learning of pitch. Once identified, each factor can then be evaluated by controlled experiment before confirming its influence. Since it is what is heard and perceived that is learnt, I have started with the process of Hearing and Perceiving, for as Arnold Abramovitz, Senior Lecturer in Psychology at Cape Town says, "the reception, processing and interpretation of acoustic symbols constitutes some of the most elusive and complex phenomena to attempt to examine, gauge and measure, due partly to the transient, ephemeral nature of sound itself."



The reception of sound, i.e. vibrations striking the ear drum causing this to vibrate, cannot normally be prevented. These sound waves are transmitted by the ossicular chain to the inner ear by which the fluid of the cochlea is set in vibration, and from there via the auditory nerve to the brain. Helmholtz's Place Theory is now accepted as being reasonably accurate although it is realized that the cochlea itself cannot have a natural frequency for each section, but that the Basilar Membrane causes variation from one end to the other and passes on vibrations of various frequencies depending on the section of the Basilar Membrane set in vibration.

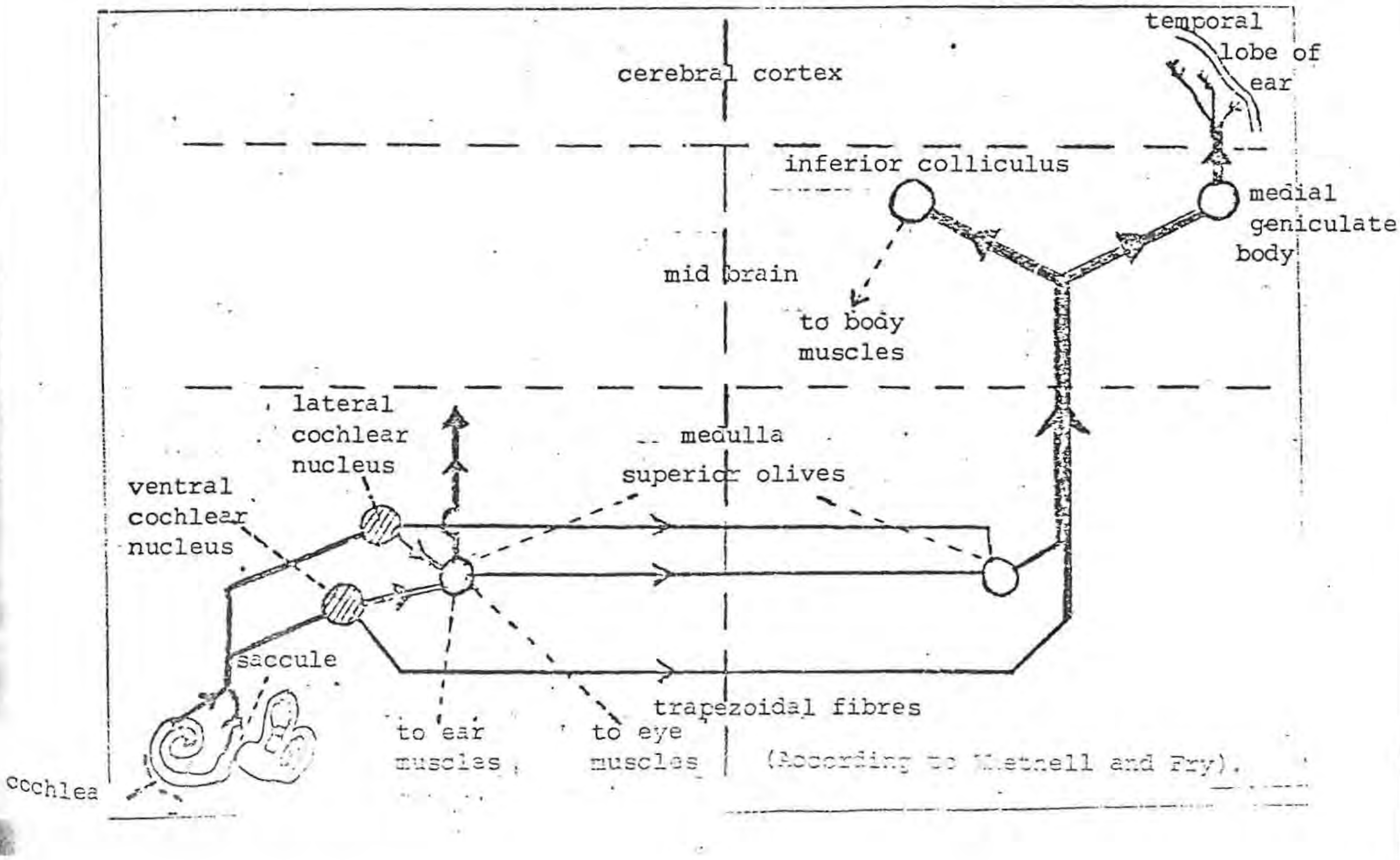
THE ORGAN OF CORTI



The Organ of Corti is composed of 7 500 functional independent units each more or less capable of independent movements. Each unit has an average of four hair cells and if each has its own nerve fibre then the total in each ear is about 30 000. These nerve fibres form the spiral ganglia; they become entwined like the strands of a rope and collectively form the auditory or eighth nerve. In this nerve, messages are received and analysed by the ear and carried up to the brain where meaning is interpreted. The entire cochlea from base to apex is one fifth of an inch.

As the footplate of stapes moves inwards at the oval window the secondary tympanic membrane moves outwards at the round window - the effect of the fluid movement in the cochlea causes the basilar membrane to vibrate. Sounds of high frequency cause rapid fluid movements near the base of the cochlea in the region of the footplate of stapes, while low tones stimulate the uppermost fibres at the apex and the intervening portion is stimulated by intermediate tones. The Auditory pathway would appear therefore to be as in the following diagram.

THE AUDITORY NERVE PATHWAY



(According to Metnell and Fry).

Bèkésy found that by applying stimuli of varying frequency and intensity to the oval window each frequency produced a response that was confined to a specific area of the Basilar Membrane, but there was extensive overlapping of the areas responding to different frequencies; that is the response to 200 c/s started at about 20 mm from the stapes, increased slowly according to intensity to a maximum at 28 mm and then decreased rapidly to zero at about 31 mm. The response to 100 c/s began at 22 mm from the stapes, reached a maximum at 30,5 mm and fell to zero at 33 mm. There is obviously therefore no exact area of the Basilar Membrane for each frequency on a one to one basis but it does not follow that sufficient information is not provided which when decoded allows for discrimination between different frequencies. It is this latter process which is more difficult to understand and which led to the following experiment.*

Galambos and Davis (1943) recorded, using a micro-electrode, the responses of isolated neurons in the auditory tract of a cat. The cat's ear was stimulated with tones that could be varied in frequency and intensity. They found for each neuron there was one frequency or narrow range of frequencies that could arouse a response if the stimulating tone was at or near the intensity threshold, but that when the intensity was increased the neuron responded to a progressively wider range of frequencies, the more so in lower frequencies. This experiment adequately demonstrates the 'Law of Neural Specificity of Pitch' which shows that the sensation of pitch depends on two different kinds of information being carried to the brain:

(a) The activity of certain fibres stimulated by a mechanical sound analyser - the Cochlea.

* (Bèkésy, G.U., 1951.)

(b) The frequency of nerve impulses in a rather large non-specific group of fibres.

J.A. Martin, of the Nuffield Speech and Hearing Centre, London, states "There is no reason to suppose that the processing of the sensory input flowing into the central nervous system, from the auditory nerves is confined to the area labelled 'auditory cortex'. The remarkable complexity of the auditory pathways in the brain-stem, mid-brain and thalamic region, lend strong circumstantial support to the contrary".

Pitch may therefore be described as a subjective quality of sound depending chiefly on the physical frequency of the sound waves and to a very limited extent on their intensity. This 'selective tuning' demonstrated by the Law of Neural Specificity of Pitch depends on the details of the anatomy of the inner ear, that is on the size, density and elasticity of its structure. An alteration of these cochlea structures would alter this tuning and bring about a failure to hear pitched sounds correctly (the pitch could be varied without a change in hearing levels). Since learning requires a 'stable behavioural field' such fluctuating structural changes of the cochlea could hinder pitch learning.

An investigation also carried out by J.A. Martin using perceptual tasks involving the discrimination of fine differences in frequency, duration, or rhythmic pattern given to a group of sixth form schoolboys, in order to provide further information about auditory perception, suggested two conclusions:

(a) Given any one auditory perceptual task, there is a wide range of ability to perform the task within a group of normal healthy young people.

(b) Given any one individual, there may be a wide variation in his ability to perform differing auditory perceptual tasks.

If, as Pavlov* maintained, the primary function of the cortex is the establishment of connections between the receptor and motor centres, the answer to the problem of pitch memory could be found in the form, quantity and quality of responses conditioned to the afferent patterns stimulated, which once established were stored in the brain, thus forming the pitch memory necessary for reference purposes. Thus it can be seen that memory (pitch memory) plays a part in pitch recognition, in that it provides the reference tone necessary for identification purposes.

Intensity then becomes an important feature of pitch learning since it has been demonstrated by Galambos and Davis that the louder the tone the more impulses each fibre every second, until the fibre is working at its maximum rate and also that the louder the tone the more sensory cells and nerve fibres are stimulated. The total number of nerve impulses delivered to the brain per second can therefore be increased in two ways:

(a) More impulses per fibre. (b) More fibres active.

As the sensation of pitch follows the transmission of nerve impulses by specific auditory fibres with possibly up to 20 ms delay, and since speech and music are not static but are patterns that change from moment to moment, Time and Duration become important factors in pitch learning, with time becoming of more importance as age increases.

According to the response evoked from the child by its environment and made possible by its hearing and vocalisation

*(Taylor, J.G.)

mechanisms during the years when the special facility for the learning of pitch exists, so will the accuracy, nature and quality of Pitch learnt be related. A study of <u>optimum environmental conditions</u> for pitch learning, the nature of the <u>Personality</u> most ready to respond, the <u>Vocalisation</u> necessary to express, contribute to the learning of pitch and develop the response to pitch together with the sources of stimulation likely to affect the nature and quality of pitch learning such as <u>Instrumental Experience</u> and <u>Tonality</u> must therefore be made. It is survival hearing (hearing for absolute pitched sounds) that is possessed at birth by all normal children and high grade animals. At this stage, i.e. approximately the first eight months of life, it is <u>pitch</u> that with training has meaning and not vocabulary. The child does not learn to hear, he learns to comprehend that which he hears by learning to first relate experiences to individual pitched sounds, the first being those most important to him. The first to be learnt are those connected with basic survival such as food preparation, mother's voice, etc. If the signal is meaningless, i.e. not related to a previous meaningful, important and pleasurable experience, or if no attention is paid to the stimulus, there will be no learning at this stage. If the child were to receive the same response regardless of the pitch of the sounds involved, or was unable to experience differences in pitched sounds as a result of a malfunctioning cochlea, etc., he would fail to learn pitch although he suffered no hearing loss. This would result in all sounds becoming meaningless noise. In other words, if the child's environment does not require him, and make it possible for him, to discriminate between pitched sounds during these early optimum years for absolute pitch learning, then he will fail to learn pitch discrimination.

Sounds must be learnt in order to be understood as demonstrated by Bunch (1943), and this affects all aspects of sound, e.g. pitch, intensity, timbre, quality, etc. The earliest signs of memory for sounds is in the second month of life.

It is unfortunate that whereas teachers and others understand the need for visual training as part of any pre-reading training, few realise the need for auditory training and the majority of these deal almost exclusively with the aspect of intensity levels and rhythmic patterns. Language requires the following skills:

(a) Pitch Discrimination. The pitch sensation evoked must be consistent in exactness of frequency and be repeated sufficiently for learning. There can be no Pitch Discrimination without both recognition of previously experienced pitch sensations and the reversibility of mental action necessary for the required acts of comparison.

(b) Pitch Memory, for both Absolute Pitched sounds and Relative Pitch.

(c) Patterns of Duration, with due attention to the need for these to be of sufficient length to enable the sensation of pitch to arrive at the cortex.

(d) Patterns of Intensity, with due regard to the need to hear all sounds over the entire speech frequency range sufficiently often and sufficiently loudly to enable first learning to take place.

Pre-reading Auditory Training must therefore include activities covering <u>all</u> these aspects of sound required for language. This can most easily be carried out through music education.

<u>Absolute Pitch</u> - or better named, the memory for absolutely pitched sounds. This skill refers to the ability to remember the exact pitch of a note, immediately and without reference to any other note. Many workers attempt to stipulate the degree of accuracy of Pitch identification, according to Hz and reaction time, which must exist before a subject can be described as possessing Absolute Pitch. For reasons explained in this work I believe there is no such thing as <u>an</u> Absolute Pitch. Other workers have suggested that the acquisition of Absolute Pitch appears to be influenced by early environment and training. Petran (1932), Boggs (1907), Revesz (1953), Whipple (1903),

Mull (1925). Mull goes on to say that there is a degree of Absolute Pitch memory in many people which is improved by training, but substantially depends on the importance that pitch has for the individual. Some claim that there is no such thing as Absolute Pitch and Meyer (1899), Riker (1946), Oakes (1955), Brammer (1957), Teplov (1966), all point to the lack of suitable criteria for the identification of Absolute Pitch. Certainly the term 'Absolute Pitch' must invite doubts of its existence, as it is in itself contradictory. How can pitch, which is a subjective sensation be absolute, when so many factors can vary the sensation?' Since any learning requires a stable behavioral field, it is not surprising that the mere act of definition is itself a difficulty. According to Sergeant it is the precise degree of accuracy that has caused the confusion in identifying the possession of Absolute Pitch. The exactness (absoluteness) of pitch learnt must surely depend on:

(a) The availability of different experiences for each difference in pitch, however small the difference limen.

(b) The finest ability to discriminate pitch to the limits of pitch discrimination, in order that the response can be conditioned during the optimum years.

The limits of pitch discrimination are larger than even a whole tone at both the extremes of high and low frequencies, but as Zwicker, Flothorp and Stevens (1957) state, we are capable of differentiating between 0,5% as a just noticeable change in frequency, which at 2 000 Hz amounts to 10 Hz and is much smaller than a semitone. We are therefore twenty times more capable of frequency recognition than our scales demand. It follows therefore that instead of being concerned about using the Pentatonic Melodies during early childhood because of the absence of semitones, we should be aiming at producing melodies which give children the opportunity of experiencing and therefore learning, to their maximum potential, i.e. melodies extending to their limits of pitch discrimination and a notation capable of identifying what we are capable of differentiating. A lack of such a notation could be a seriously inhibiting factor.

I have therefore formed the opinion that there is no such thing as an Absolute Pitch, i.e. a single ability of pitch learning accuracy, but that pitch is learnt with varying degrees of Absolutism (i.e. the exact identification of the frequency) according to the opportunity afforded the child during the optimum years. Immediacy of response is also of great significance as immediacy is the only known tes of 'trigger response' or as it is sometimes called, 'conditioned response', a response arising from early conditioning of sensory stimulus to cue, but involving no mental process of reasoning or relating. Absolute Pitch learning requires no reversibility of mental action. Teplov claims that the speed in which the judgement is made is the criterion. Certainly all workers agree that the quicker the judgement the more accurate it is, i.e. from 0,4 to 0,7 seconds for A.P. subjects, but non-A.P. subjects require anything from 2,5 to 24,0 seconds in addition to some form of mental process. The learning of Absolute Pitch could best be described as the building of a repertoire of pitched sounds stored in the brain to form a pitch memory, to be later recalled in any activity requiring it for reference purposes. A study of the acquisition of A.P. by Sergeant shows that some 27,7% initially had A.P. only for one note, which then spread to adjacent notes and then similar notes at other octaves. (Du Preez reports similar progress in the child's language acquisition.) Jim Baggaley in his "Measurements of Absolute Pitch" refers to Stumpf's view that A.P. is an extension of Relative Pitch. In my opinion, it is the other way round.

Relative Pitch can be shown to develop after the optimum period for the finest learning of Absolute Pitch has passed. For greatest efficiency it is dependent on the degree of A.P. learning that took place in the optimum years, as recognition of melodic outline requires relative pitch learning but the fixing of the pitch of the melody requires some learning of Absolute Pitch. Many writers have demonstrated this difference. Meissner* showed that many children could reproduce the melodic outline of a tune heard once, but failed in accurate reproduction of intervals. Brehmer (1925), Stern (1927), Gessell and Ilg (1946), have all shown this difference in perception between melodic shape and the perception of intervals requiring some degree of Absolute Pitch learning.

Relative Pitch is concerned with the memory of relationships between the Auditory stimulus and at least one other, i.e. Visual, Spatial, Tactual, Motor and/or Kinaesthetic. It requires reversibility of mental action, an ability not normally fully developed until about six years of age, and the standard achieved is directly controlled by the individual's ability to relate earlier learning. It is acquired by conditioning of at least one other stimulus with the Auditory Stimulus. It would appear moreover that the acuity for individual pitched sounds must first drop a little, to enable the child to become less preoccupied by the individual sounds before he can begin to relate sounds one to the other, and form meaningful wholes. (This was also found by Pflederer Zimmerman 1974.) This was

*(Pflederer-Zimmerman, M., 1974)

further demonstrated by a group of six music students at the Guildhall School of Music who had acquired Absolute Pitch but found great difficulty in using Tonic Solfa. Isolated Pitched Notes were played without reference tones and with chromatic chords played between each sample tone to destroy any lingering tonality. The students were usually able to name the notes quickly but would then have to spend much time working out the tonic solfa. They appeared to be so concerned with the exactness of pitch that they could not describe any mental effects which the degree of any scale suggested to them, nor its relationship to any other degree of the scale. As Pflederer Zimmerman argues, it is only when decentring begins can perceptual information be adequate for concept formation. The processes of learning to relate sounds, i.e. the establishment of a feedback system and the individual's ability to relate as demonstrated by his intelligence, and to function as affected by health and developmental problems such as puberty, must also therefore be considered as factors affecting pitch learning.

The Auditory-Visual conditioning has proved to be the most effective in the learning of relative pitch, but the simultaneous firing of all stimuli has produced the greatest efficiency. The results of work with the blind, where a visual cue has not been possible, shows that other cues are possible as a substitute for the visual cue but they are not as efficient.

Throughout this research any factor appearing to affect pitch learning has been noted and explored by means of a separate pilot study. When the study has confirmed the impression, then a hypothesis has been formulated and a controlled experiment has been set up in order to test it. The observations, and controlled experiments and occasionally the pilot studies, have all been included in this thesis since all contribute to learning and describe how the thesis itself has evolved into its present shape and content.

The thesis can be described as setting out to prove that the possession of Absolute Pitch is not an inherent ability but is learnt; that the term 'Relative Pitch' is not describing a different skill, but merely the pitch identifying procedure that can be acquired once the optimum years for the learning of absolute pitched sounds past, that the learning is entirely age controlled with the influencing environmental, psycho-acoustical and behavioural factors involved, being those present during the optimum age for pitch learning - hence the controlling nature of age. It also shows that age controls not only whether pitch is learnt to any degree at all of absolutism, but the quality and nature of the pitch that is learnt, as it is the quality and nature of the pitch stimuli presented and perceived during these optimum years, that is learnt.

The thesis further identifies the optimum years as the pre-puberty years, and therefore the responsibility not only of parents, but Nursery and Primary School teachers. The thesis has been developed to include a critical study of current teaching methods and procedures for the teacher in the light of this research, some Conclusions and Suggestions for Teachers and a Summary of relevant factors affecting the school curriculum generally.

The work aims at identifying those aspects of the acquisition of basic communication skills, i.e. speech, reading, spelling and writing that are affected by pitch perception and discrimination. This is felt to be necessary as it may not be apparent to the non-musician Educationalist, Psychologist or Audiologist, that pitch learning has any relationship to their field of study. The writer stresses this with some urgency as she has formed the opinion as a result of this research that:

(a) Failures to acquire a pitch memory with the consequential disorders of communication, literacy and intellectual development, are often wrongly described as central disorders whereas it is often lack of opportunity to learn at the '<u>once only</u>' age.

(b) Pitch Discrimination and Memory problems without hearing losses are often the root cause of aphasia.

(c) Pitch Discrimination and Memory and/or minimal hearing losses are probably the cause of the majority of cases of so-called Dyslexia.

(d) Very minimal hearing losses which are occasionally described as too small to be of significance often appear to be sufficient to cause reading problems unless auditory training is carried out.

With this in mind she hopes that the thesis will bring about an awareness of the importance of pitch training and its inclusion in Music Education.

She further hopes that all concerned will become aware of the need to accept Music Education as a means of providing pitch training as a basic essential for the Nursery and Primary School classroom. It is her considered opinion that it is only in Music Education that the child can receive auditory training in an educationally logical manner. Music can present each of the four basic auditory components of language individually and progressively, i.e. from the simple to the complex. In language they are presented simultaneously and are immediately complex. It is therefore possible that language failure could be prevented by the use of music as auditory training. To do this one must start by training the Nursery and Primary School teachers. All too often teachers find themselves at the frontier that separates music as an aesthetic pleasure and music as a therapeutic force (Du Toit, 1976), and they have insufficient understanding and knowledge to proceed further.

SECTION I

ACOUSTICAL FACTORS

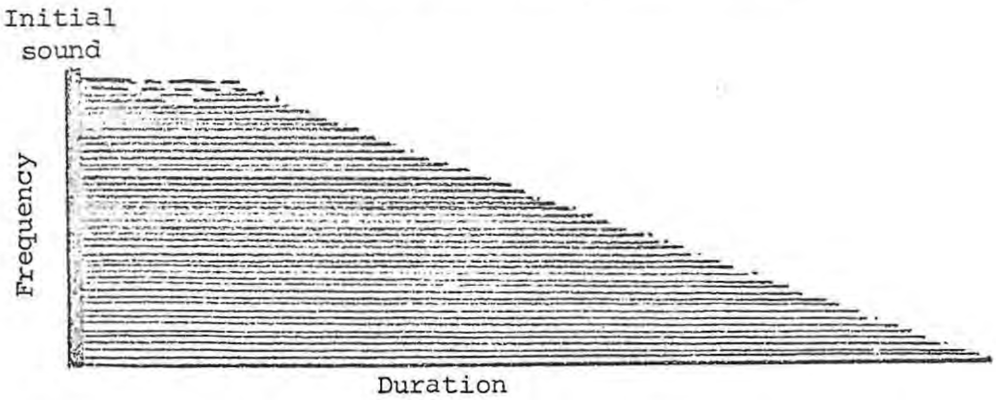
Duration. We all have an acoustical system which when excited by random noise will behave discriminately picking up its own frequencies. The External Auditory Meatus is a closed tube resonating at 3 000 Hz to 4 000 Hz, hence the extreme sensitivity in that frequency range.

A complex tone, as all musical tones are, consists of a fundamental frequency and its harmonics varying in distribution and intensity. The ear is able to break down the complex tone into a number of pure tones by the process of Fourier Analysis. By Ohm's Law of Acoustics one is able to analyse these complex sounds into a series of pure tones. Musical Tones have fundamentals combined with seven or eight effective overtones reaching as high as three octaves above the fundamental. Musical sounds are perceived to be louder than non-musical sounds because the overtones are in the more sensitive part of the hearing, i.e. a Pure Tone of 40 dB S.P.L. at 2 000 Hz will appear louder than the same S.P.L. at 500 Hz or 8 000 Hz.

The pitch of a complex tone is determined by its fundamental and the distribution and intensity of its partials. Discrimination of Complex Tones is easier than for Pure Tones as further information is given by the presence of the harmonics.

The Analysis of a Complex Tone showing the gradual

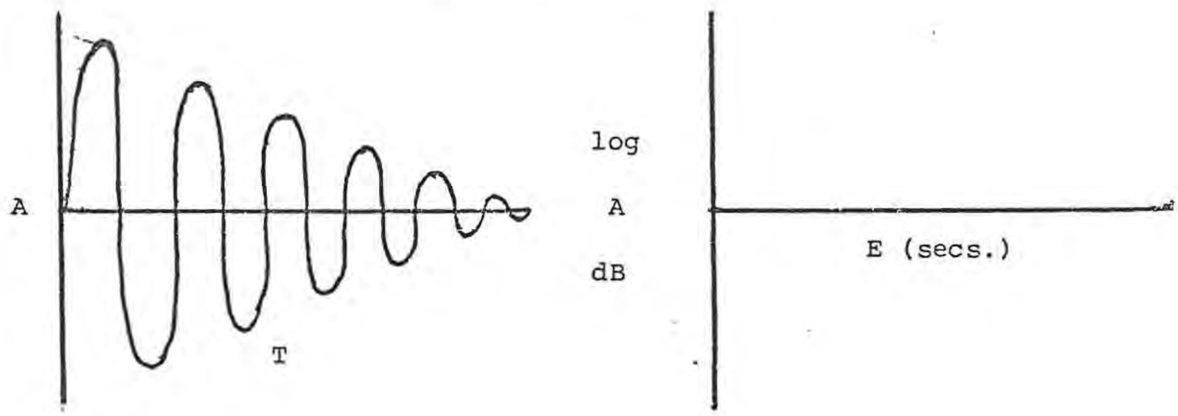
fading away of the higher harmonics



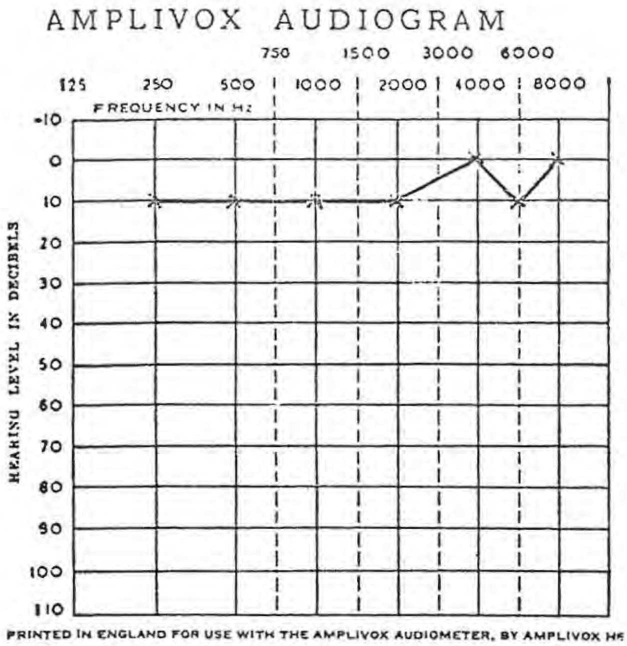
Analysis of the sound generated by the striking of a piano key. Here the amplitudes of the fundamental frequency and its harmonics vary with time.

The decay rate of a tone as illustrated by the diagram below is therefore important, particularly in view of the time required before experiencing the sensation of pitch.

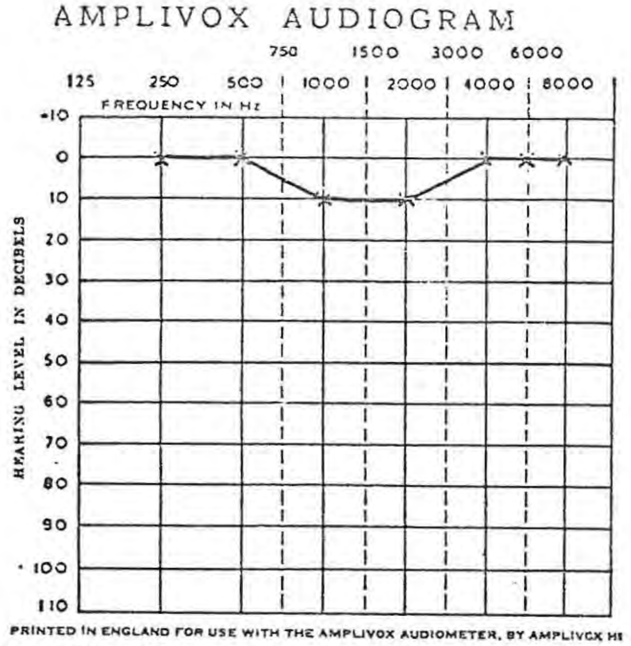
Decay of Tone



Decay rate: 5 dB per second in air; 10 dB per second in bone. A sound heard for eight seconds longer means 40 dB difference in hearing. Pitch discrimination is therefore better for longer tones. This can be illustrated by Pure Tone Audiometry which shows a distinct shift of threshold when longer tones of the same frequency and intensity are presented to the ear.



SHORT



LONG

Von Békèsy also claims that pitch discrimination is better for long tones than for short tones. (Békèsy, G. Von., 1963).

<u>Duration of Stimulus for Sensation of Pitch</u>. The duration of the stimulating tone at 1 000 Hz was perceived at the subjective pitch of:

840 Hz when lasting 0,01 seconds

935 .... 0,015 "

950 .... 0,02 "

980 .... 0,025 "

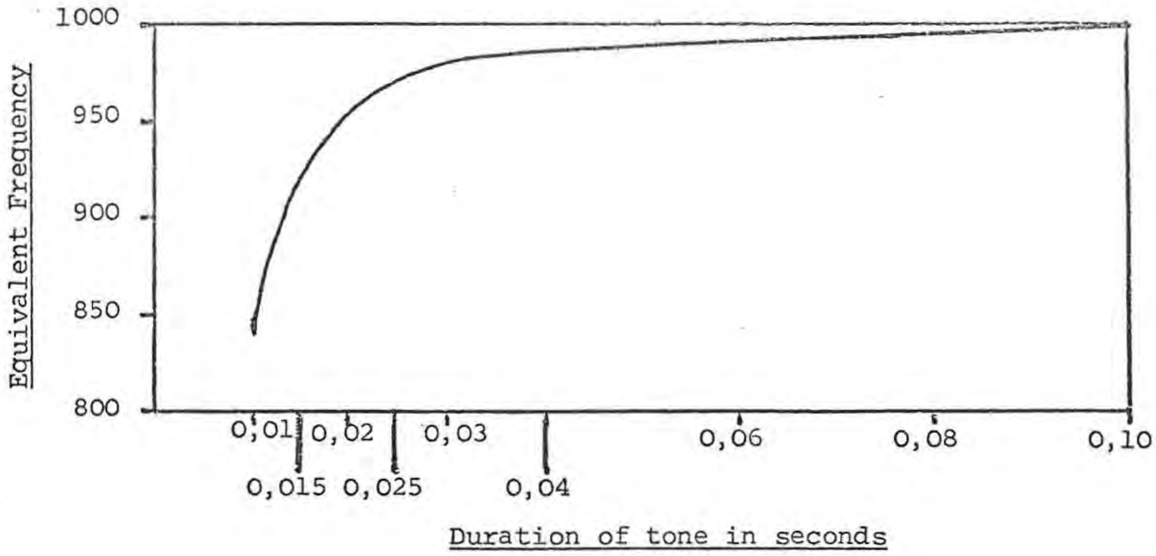
985 .... 0,03 "

990 .... 0,06 "

995 .... 0,08 "

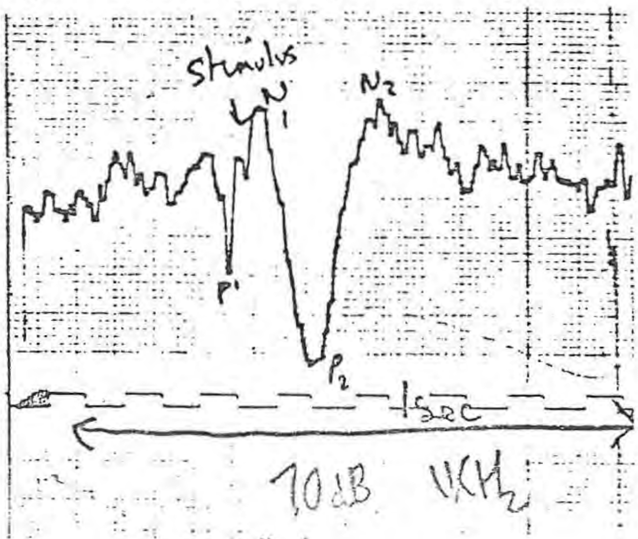
995 .... 0,10 "

<u>The variation of the pitch of a tone as a function of its duration</u> (Sergeant, D., 1969). This is further complicated by the fact that the loudness of a pulse increases up to a duration of a second or so.



(1) Record of brain activity during one second of a person sitting in a chair.

(2) Record of brain activity during <u>one second</u> of the same person sitting in the same position listening to a pure tone (two octaves above middle C) with a computer extracting the actual response to the sound. Note the build up in response; this varies according to intensity and age of the person, the younger person having the greater response.

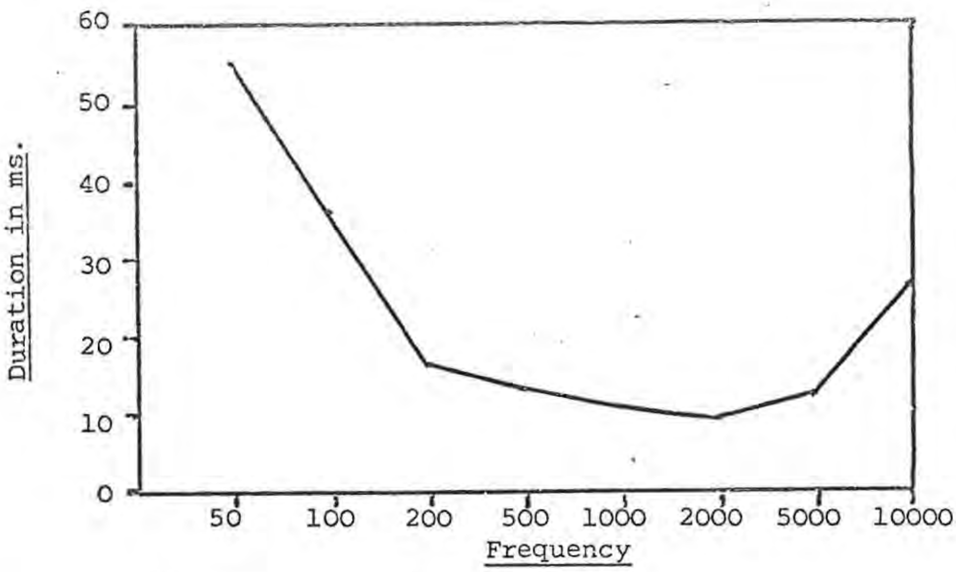


In addition to these delays in the build up of the sensation presumably due to mechanical action, there is the possibility of the synaptic delay of up to 20 ms in the transmission from the end organ to the cortex.

When a sense organ is stimulated excessively, it is found that the period of rest required before the maximum sensitivity can be achieved again becomes prolonged. The more obvious measure for fatigue is the temporary change in threshold of audibility - a fatigued ear cannot be excited by a change in intensity. J.C. Flugel found an apparent displacement of tone towards the unfatigued side, he also pointed out that fatigue depended on duration of stimulus. Bekesy found that fatigue due to a tone at 800 Hz caused apparent sharpening of pitch of the higher frequencies and flattening of pitch for the lower frequencies. Ewing and Littler showed that fatigue was a function of frequency, intensity and duration, with the effect being greater for the higher frequencies. All the experiments showed a large variation among individuals. It has also been shown that the 'mechanical excitation of the cochlea takes a certain time to reach maximum at a specific place'.* Experiments have been made on the length of time that a pulse of sound must last before it will give a sensation of a definite pitch.

The graph on the following page shows the duration required for a given tone to produce a definite pitch (Burck, Kotowski, Lichte). It was also found that the shorter the duration the lower the apparent pitch, and according to Ekdahl and Stevens it is necessary for a pulse to last as long as 40 ms before the long duration pitch is established.** Duration of the sound is therefore an important factor to be considered by the teacher if this affects the sensation of pitch.

*(Sergeant, D., 1969).
**(Stevens, 1963).



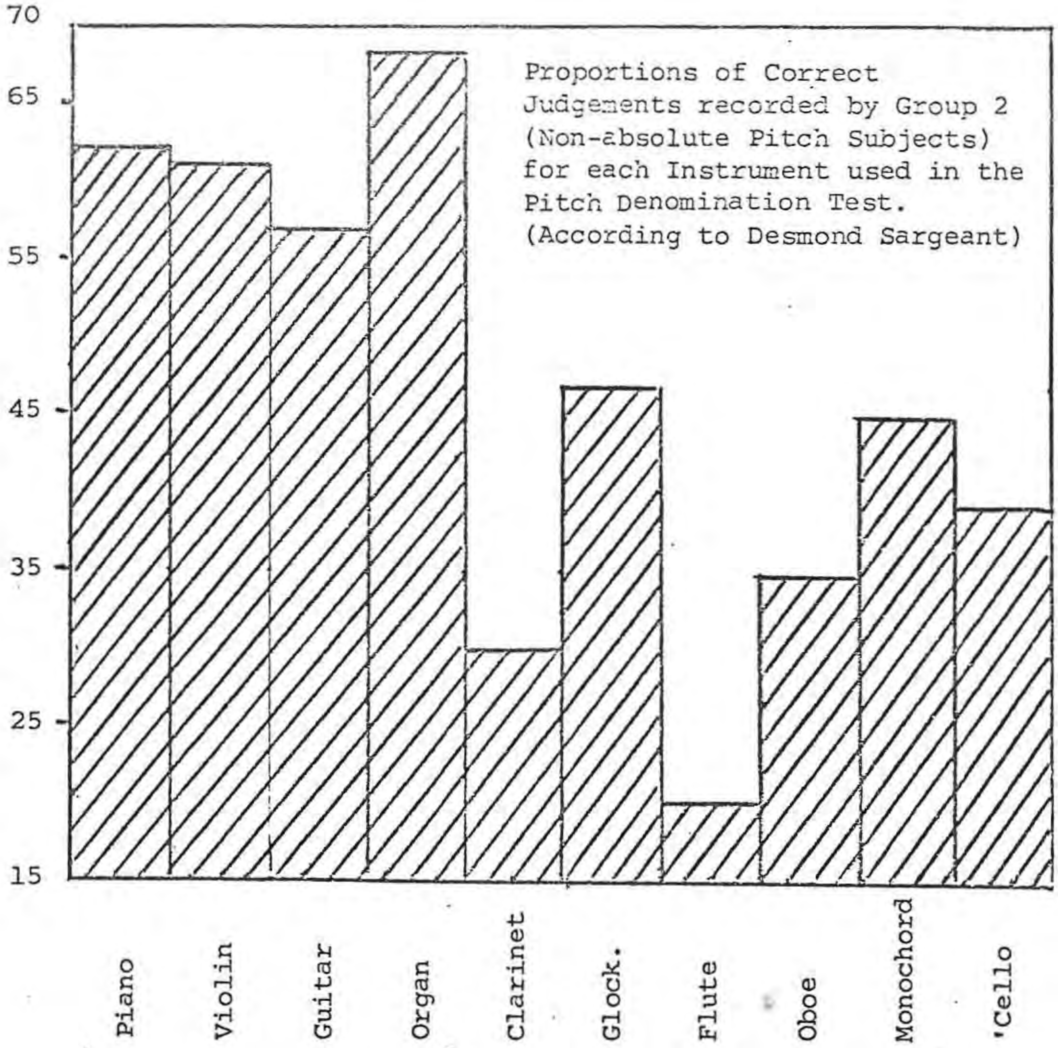
When experimenting with the Training Programme described in the Appendix I found that complex rhythmic work introduced too early in training retarded pitch learning (as indeed did Steiner and Teplov,1966). I believe this to be mainly a question of duration. In Hungary (although I could find no one to admit it), I found that the tremendous amount of rhythmic work done in the Music Primary Schools, did cause a lack of sensitivity to pitch. I also found that in the Music Academy the students who had excelled in the Music Primary Schools, and completed a considerable amount of early rhythmic training nearly (forty minutes a day, from the age of six years) by the time they were nineteen years of age his rhythmical ability had started to decline. Bentley also records a retrograde step in this ability, when he notes that unselected fourteen year olds performed better in rhythmic tests than music students and adults. These facts, coupled with the distracting influence of rhythm or as Sargeant says, "it is easy to disorganise the normal function of the brain by rhythm", should make it clear that the damage done to pitch learning by too much complex rhythmic work cannot be justified on any grounds.

In my opinion, it is a similar problem as when learning to read, i.e. a question of eye fixation when the learning of an individual sound is being conditioned to a visual cue. Each sound must be heard sufficiently often, loudly, and of sufficient duration. When complex rhythms are used the individual notes are often not of sufficient duration for the sensation of pitch to arrive at the cortex. Learning can therefore not take place.

Rhythmical work must, however, continue separately to bring about the recognition of musical phrases and sentences. The simple examples on page 79 showing the increased recognition of pitch for longer notes further illustrate this point. Variations in the response time to pitch according to the duration of the stimulating tone have also been noticed during the Menstrual Cycle (V.T. Wynn - Progress in Neurobiology, 1973). It is further shown that the response time to pitch according to duration of the tone increases with age, the tone needing to last considerably longer for the elderly to achieve the sensation of pitch.

Dr. Fisk of the Nuffield Speech and Heating Unit in London, showed by experiment that the young child's response in auditory discrimination was far more acute in the early morning, but that auditory fatigue set in after only ten minutes among the very young, and fatigue brought about a delay in response.

The following diagram, prepared by Desmond Sergeant, showing notes played on a variety of instruments helps to illustrate the possible effects of duration on pitch learning. This is shown by the increased score obtained when using instruments with minimal tone decay.



Dynamics.

"The ear of man is not so sensitive to changes of volume as it is to changes of pitch" (Negus).

Training which includes attention to dynamics appears to affect sensitivity of intonation far more than training which only covers intonation. Nowhere is this more apparent than in the Music Primary Schools of Hungary, where children churned out with ease complicated, but deafening rhythmic patterns and somewhat insensitive singing to tonic solfa. In the one Primary School where sensitivity for tone and intonation was shown the teacher insisted on training at the softest level possible for hearing. The effects of this on sensitivity of both tone and intonation were particularly noticeable when compared with the other Primary Schools.

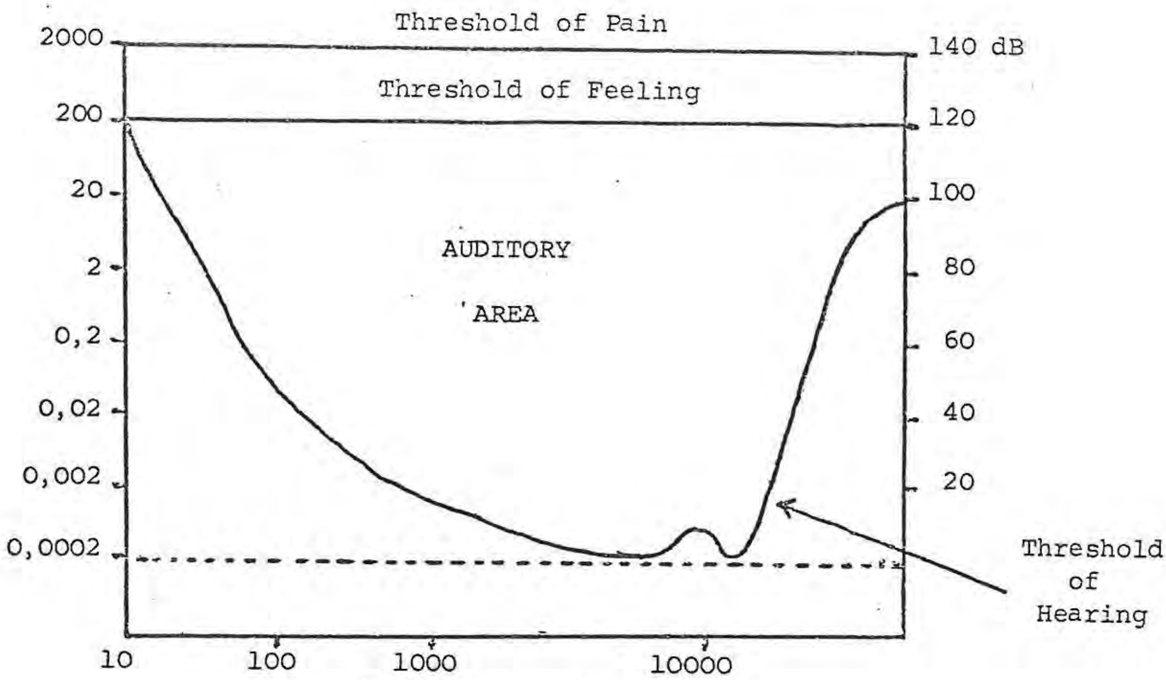
That amplification can cause distortion, can easily be demonstrated and the problems involved in pitch learning as a result of distortion, can be understood by a study of sensori-neural hearing losses. A similar problem exists when musical tones are played too loudly and the attack is too harsh. The sharpness of attack can play a role in determining pitch since a legato sound with the same frequency, apparent pitch, loudness, and even the same quality by the instrument, can be given another quality by sharpness of attack.

Loudness attenuation as a function of tone duration, must also be considered, as for Staccato to be played 'f' one must hit the keys harder than Legato 'f' (Roederer).

Distortion caused by a sensori-neural hearing loss can make music appear as an unpleasant noise - sufficiently unpleasant to cause rejection of music as an unpleasant, even painful experience, to a young child with such a hearing loss. (A selective frequency hearing aid could in some cases prevent this by amplifying the deficient frequencies.)

I wonder how often the lack of interest, or even active dislike of music shown by some people, was brought about by this consequential rejection of music during the optimum years for pitch learning, which after all is the first step towards music literacy upon which all future development is based. In order to fully understand this possibility I have summarized some of the data on aspects of the sensitivity of the normal ear.

Sensitivity of Hearing

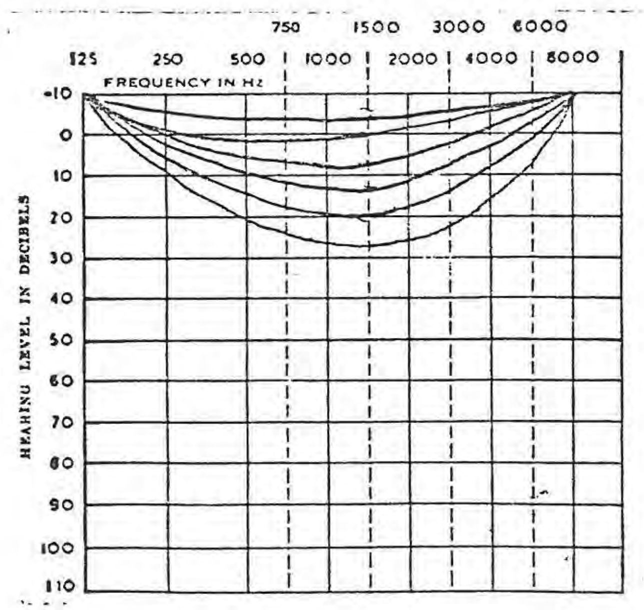


Frequency in Hz

The peak of hearing is about 3 000 - 4 000 Hz.

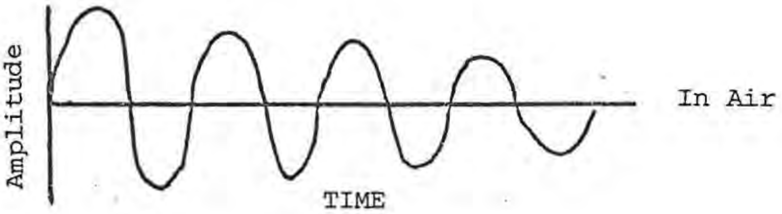
The variation of the sensitivity of the ear according to the frequency is further illustrated by the Equal Loudness Contours.

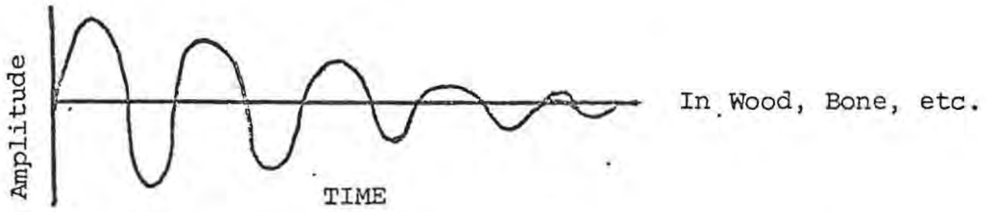
Equal Loudness Contours



The sensitivity graph was derived from data obtained from one hundred subjects possessing normal hearing, ages ranging from 20-25 years, 50 male and 50 female - the spread in normal hearing was 15dB either side of the threshold of hearing, set by 150. (Knight, J.J., 1971).

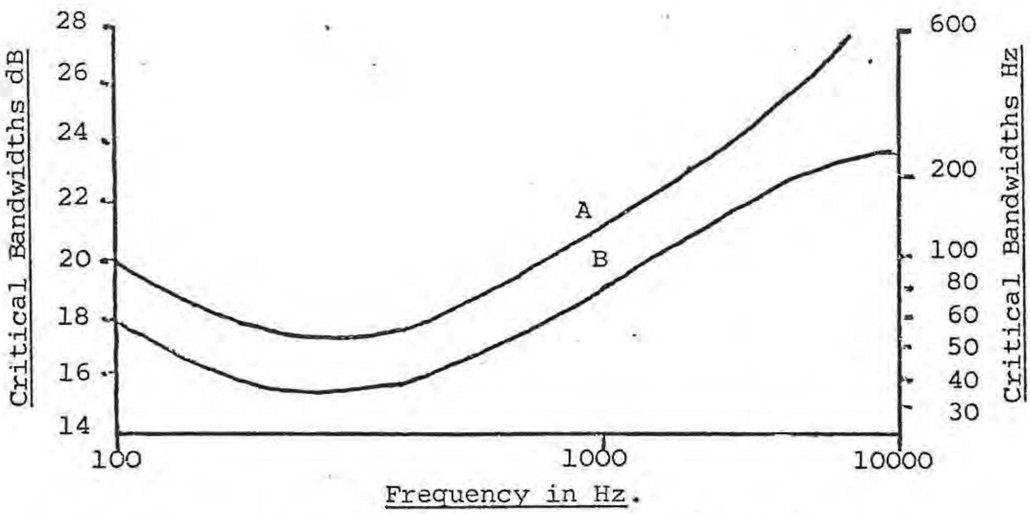
Sound is caused by something vibrating - there must also be a means of allowing transmission of the sound, i.e. air, wood, etc.





In wood, bone and human tissue, sound waves decay quicker as I have attempted to illustrate diagramatically. This is of importance when considering non-sustained tones and foetal hearing. With normal hearing a sound is heard louder by air conduction than bone conduction because the whole skull is vibrating. An obstruction in the middle or external ear results in the person hearing better by bone conduction. Because ultrasonics can be transmitted through other elements, e.g. water, they are often used for investigation in the marine, industrial and medical fields (i.e. exploring the brain for tumours, detection of submarines in water, flaws in metal, etc.). The sound is reflected when its pitch is obstructed or diverted. The conduction of sound through fluid must be considered further when assessing the hearing of the foetus in the womb. The ear is more sensitive to some frequencies than others and sensitivity graphs can be drawn up on this basis.

Binaural Hearing, i.e. with two ears, was found to be more sensitive than Monaural to approximately 6 dB difference in hearing available.



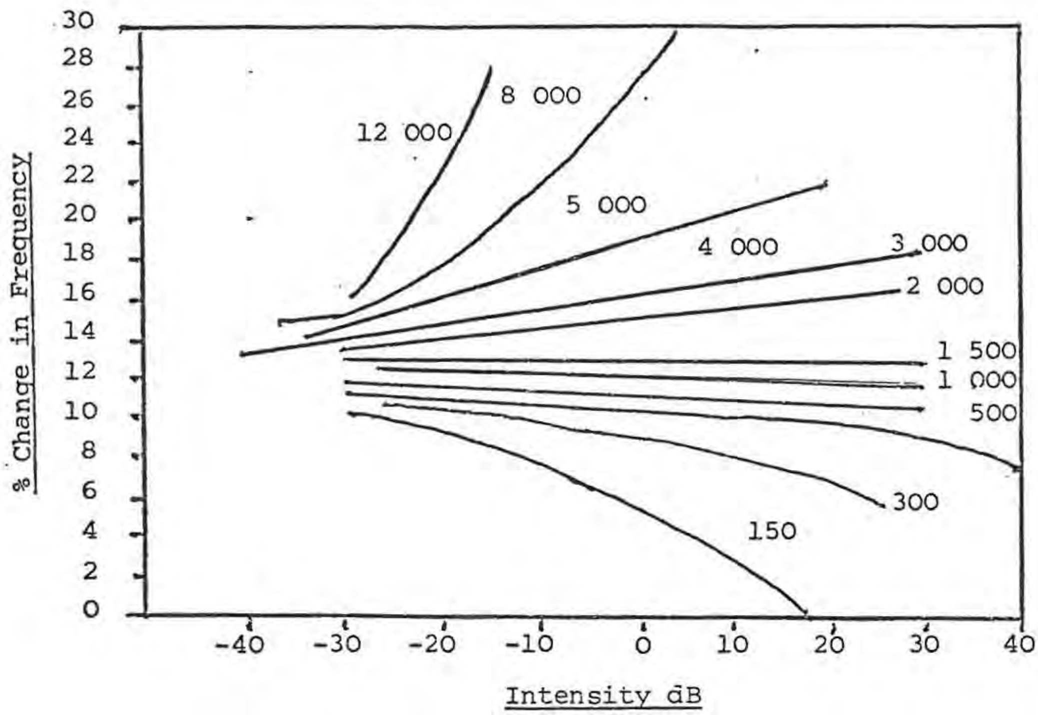
(A) One ear listening. (B) Two ear listening.

(French and Steinberg, 1947)

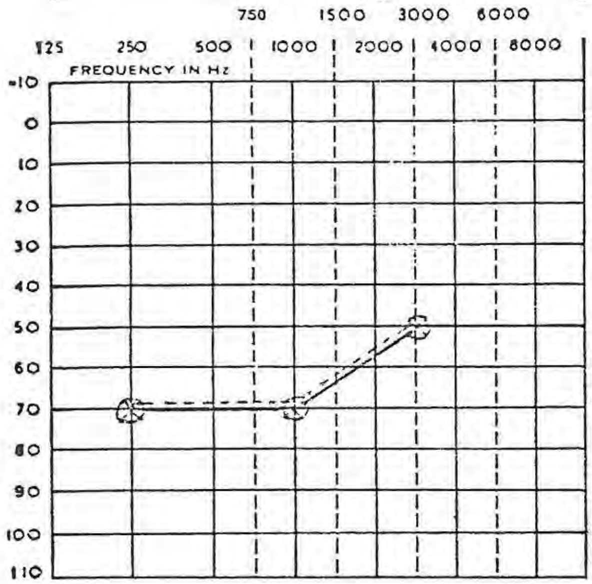
Memory and Choice of Ear. Dr. Kimura found that different snatches of music presented simultaneously one to each ear so that the subject must then select from a series of four items played successively the two played previously, resulted in the left ear performing better than the right.

Juan G. Roederer, Department of Physics of the University of Denver, also draws attention to Binaural fusion, e.g. the process of merging into one tonal image the input from both ears. He explains how pitch differences are averaged out between the ears. Pitch and Frequency are closely connected, but not entirely so. Very slow vibrations can be sensed but it requires frequencies of above 15 Hz before the tonal quality appears. For a Pure Tone, if the frequency is kept constant the pitch will vary with intensity - this can be illustrated by a Tuning Fork held at different distances from the ear. Stevens (1935) studied the problem of finding by how much a tone of intensity differing from the standard has to be changed in frequency to appear to be of the same pitch, by presenting tones of different frequencies between 150 Hz and 12 000 Hz to an observer and allowing him to adjust the intensity of one, until it appeared to be of the same pitch as the other. A difference of intensity was made to equate with a difference of pitch. The results were found in the diagram of contours shown below, from which it is apparent that for Pure Tones of 1 000 Hz downwards pitch decreases with intensity, while for 3 000 Hz upwards pitch increases with intensity, with the frequency range between 1 000 Hz and 3 000 Hz showing little variation.

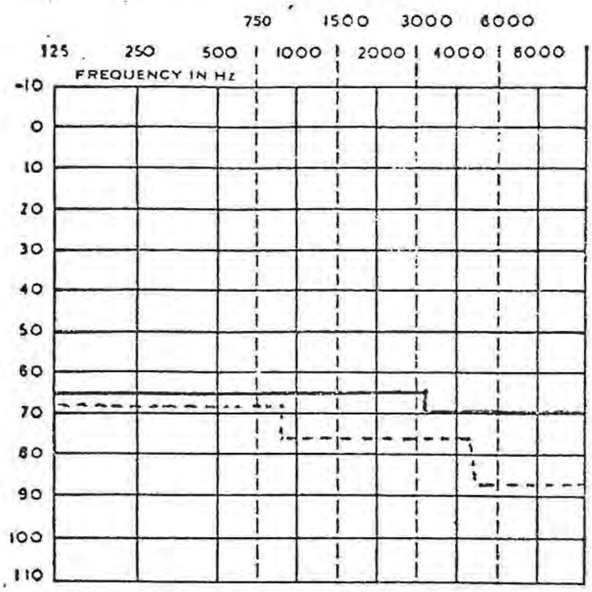
Contours showing how pitch changes with intensity (Stevens, 1935)



In considering the effects of Intensity Levels in relationship to children's response to music, it is interesting to note the following tests results and their similarity. One test being the results of E.R.A. and the other the responses noted during a filtered music session. (My query would, however, be whether the filtered tests would in fact pick up a high frequency loss in all subjects, especially those of superior intelligence. Surely there is the possibility of perceptible aural harmonics reaching sensation level? (See the work of Stevens and Davis and Guberina described on page 31.)



Evoked Response Audiometry.
Pretoria University, 20.9.73.

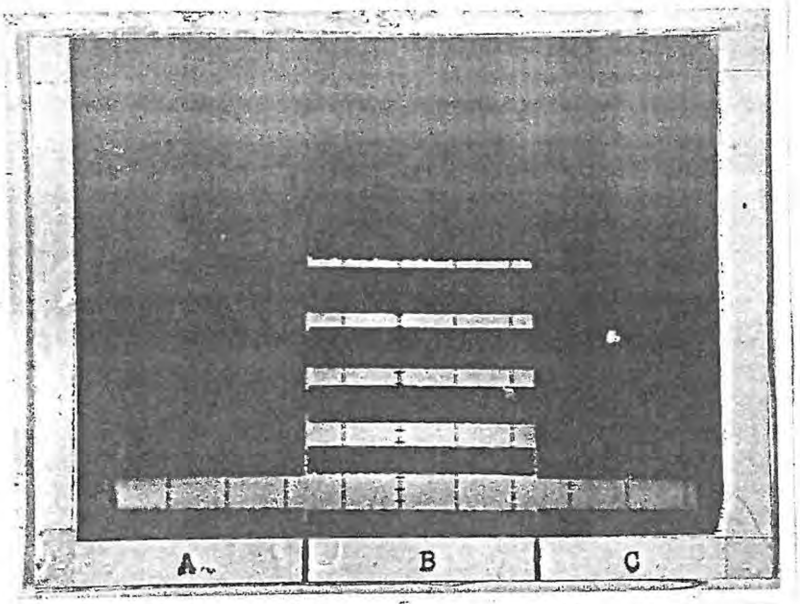


Forrest Town Cerebral Palsy School
Filtered Music Technique
Free Field. 17.9.73

<u>Dynamics in Pitch Learning</u>. In order to demonstrate that certain musical tones are perceived as louder than Pure Tones of the same frequency and amplitude thus enhancing learning possibilities, I prepared photographs of the spectral analysis of some taped examples.

Basically the reason for this is in the frequency dependency of the human ear, which is at its most sensitive at frequencies between 1 000 Hz and 6 000 Hz. Most musical tones have several harmonics within that range. A comparison of the photographs of the spectral analysis together with listening to the tapes will illustrate this.

Example One



The photograph shows the

Fundamental of 250 Hz.

a) 7 seconds Pure Tone.

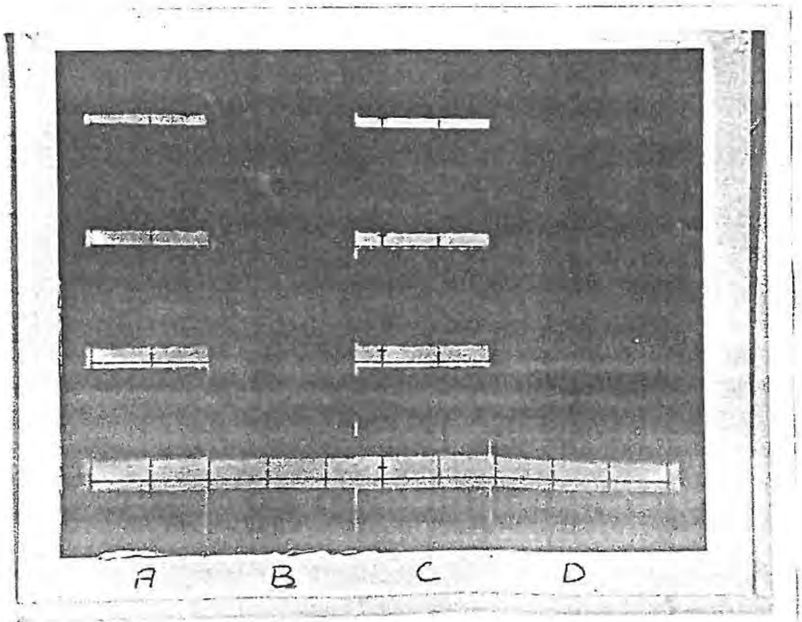
b) 7 seconds Square Wave.

c) 6 seconds Pure Tone.

The photograph shows the analysis of the fundamental frequency 250 Hz (Pure Tone) followed by the Musical Tone including harmonics with the amplitude remaining the same. Listening to the tape cassette makes this clearer.

Examples two and three of the fundamentals 500 Hz and 1 000 Hz at the same amplitude also illustrate the effects of an increase in frequency of the fundamental.

Example Two



Fundamentel 500 Hz.

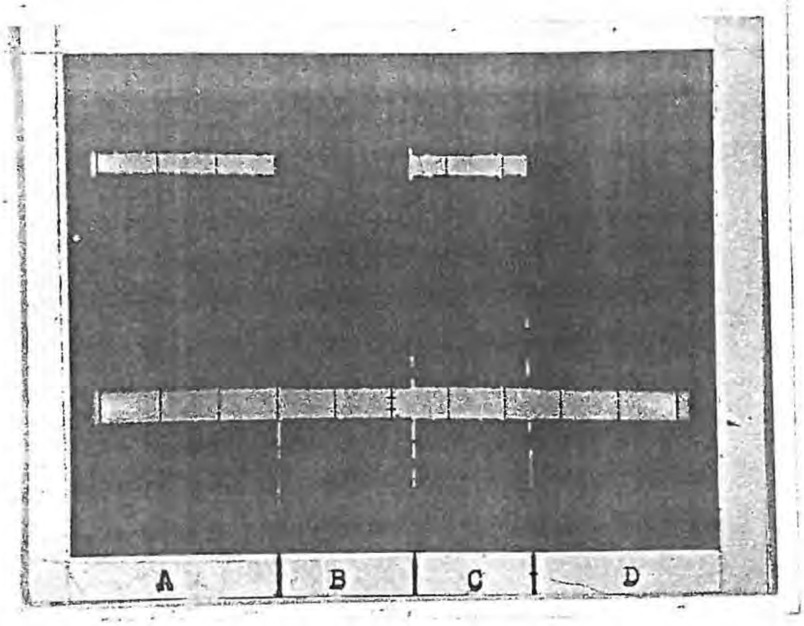
a) 4 seconds Square Wave.

b) 5 seconds Pure Tone.

c) 5 seconds Square Wave.

d) 6 seconds Pure Tone.

Example Three



Fundamental 1 000 Hz.

a) 6 seconds Square Wave.

b) 4½ seconds Pure Tone.

c) 4½ seconds Square Wave.

d) 5 seconds Pure Tone.

A study of the photographs shows the variation in the sensation of the order and strength of the component overtones according to Stevens and Davis. The importance of considering the sensations of the order and strength of these is illustrated in the two diagrams on the following page, taken from 'Hearing; its Psychology and Physiology', by Stevens and Davis, as although many disagree with these findings all must agree that the perception of the order and strength of overtones gives vital information necessary for the identification of pitch.

Henning (1965) describes the effect of Aural Harmonics on Frequency Discrimination in his article in the American Journal of Acoustics.

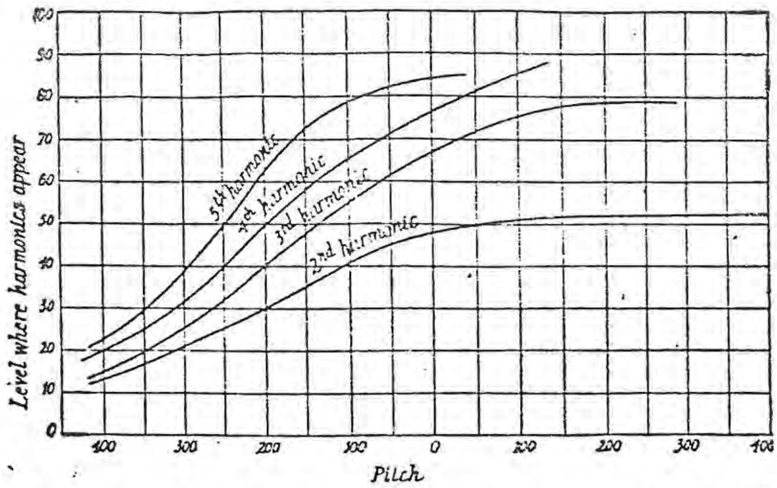
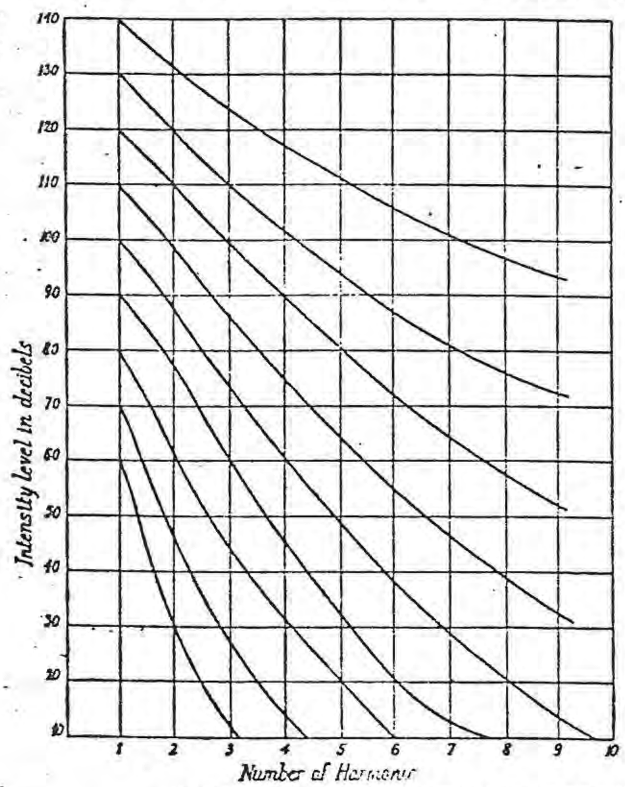


FIG. 6.4.—Sensation levels at which aural harmonics become perceptible. The pitch is measured in hundredths of an octave from a pitch of 1,000 cycles per sec., which is taken as zero. The sensation level is in decibels above the minimum audible

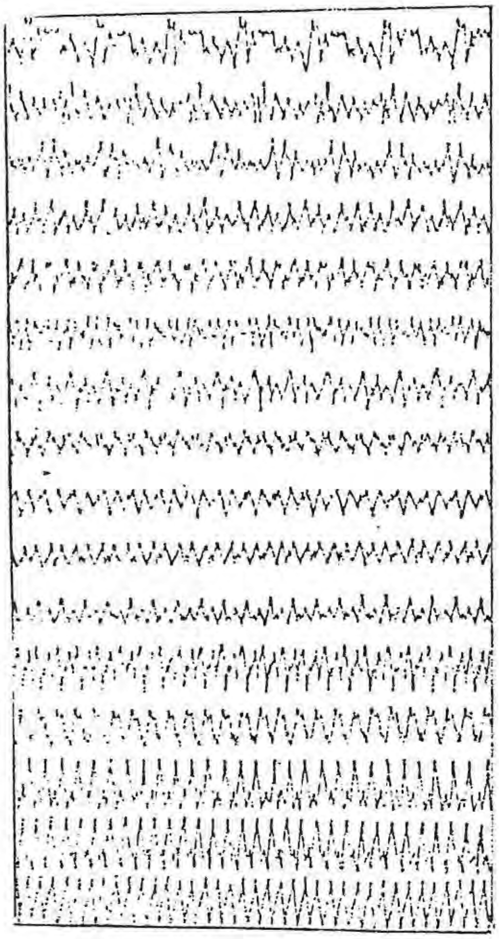


Reprinted by permission from *Hearing: Its Psychology and Physiology*, by Stevens and Davis, published by John Wiley & Sons, Inc.

FIG. 6.5.—Relative intensities of aural harmonics. The starting-point of a line on the ordinate 1 gives the intensity level of the fundamental, while the intersection of the line with the other ordinates gives the intensity levels of the corresponding partials

Distortion will seriously hamper pitch discrimination. Distortion can be caused by actual re-arrangement of the order and strength of overtones caused by the sharpness of attack or by the subjective sensations of variation described above. It is therefore important that for the most accurate learning of pitch, the training is carried out at the softest level possible according to the individual's threshold of hearing.

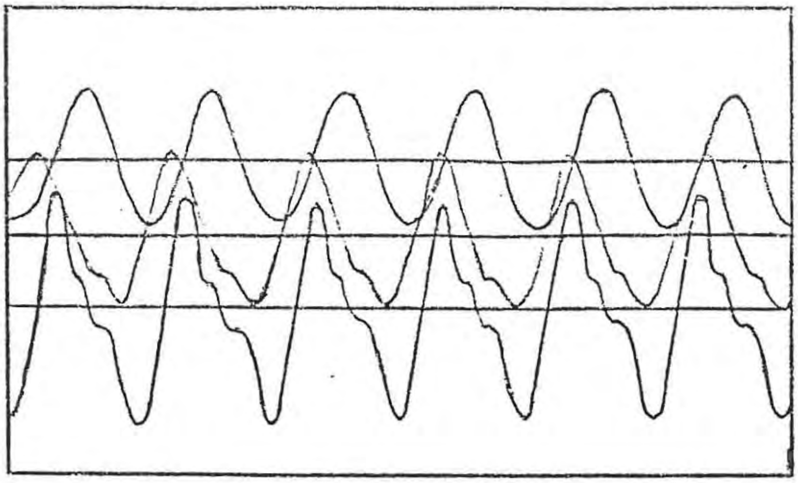
The following recording of sound waves shows the change of tone quality in the oboe with increasing pitch. A similar simplification occurs if we produce a series of tones from loudest to softest on any single pitch.



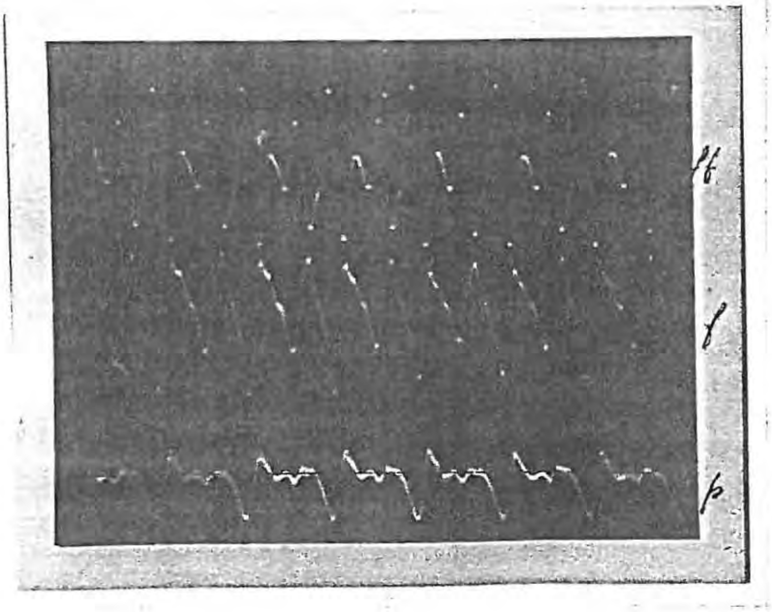
According to Dayton C. Miller. 'The Science of Musical Sounds'.

This clearly illustrates the importance of the consideration dynamics in pitch learning.

The variation in sound curves of a pitched note according to the dynamics at which it is played, is further illustrated by Dayton C. Miller in the following photographs:



Diagrams illustrating the simplification of wave form of the same note played on the flute varying the dynamics from ff to p



Played ff

Played f

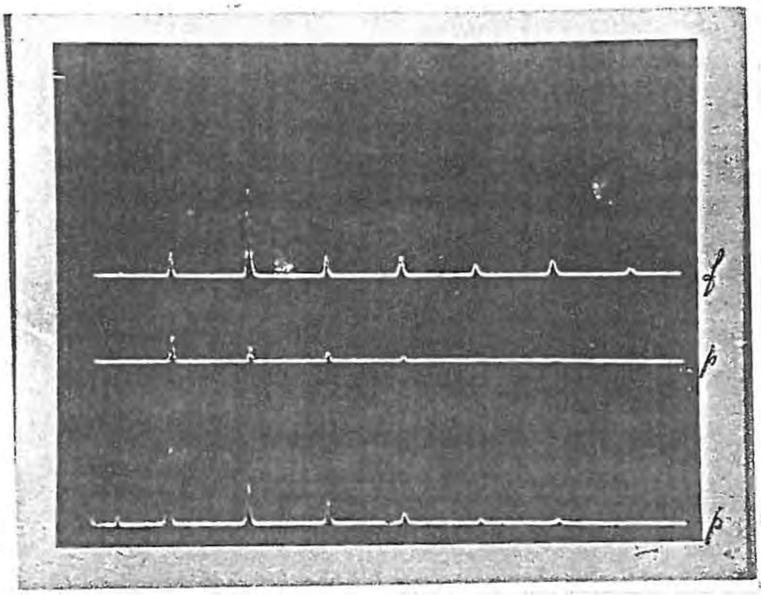
Played p

Flute wave forms - Middle C

Flute Spectrum - Middle 'C'

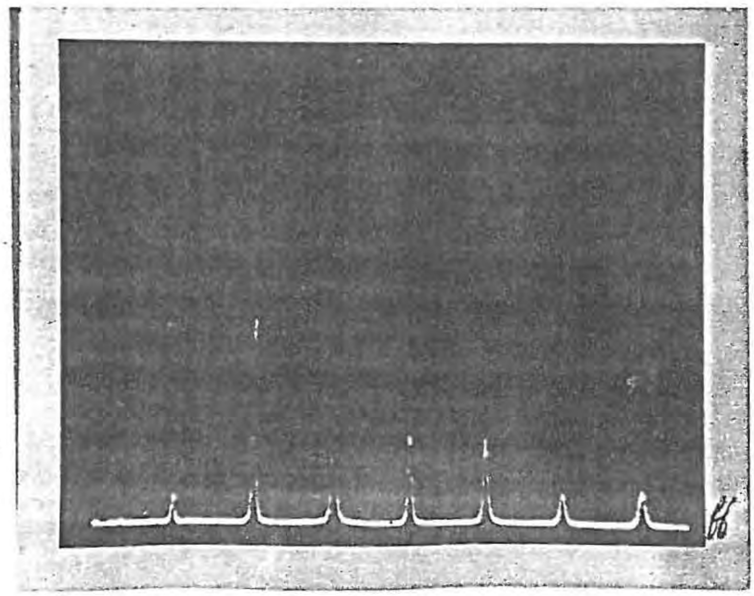
From the photograph it can be seen that the fundamental component at 134 Hz has the same amplitude for ff, f and p.

PHOTOGRAPH 1



For f the second harmonic is greater and for p the fundamental has the largest amplitude. To show the p to better advantage this has been repeated with increased sensitivity at the bottom of Photograph 1.

PHOTOGRAPH 2



For ff the third and second harmonics have much greater amplitude.

Frequently one hears that Hearing Levels are not related to Auditory Perception and Audiograms of subjects with proven ability in auditory perceptual skills are produced showing reduced hearing levels. During the stage (approximately the first six years of life) when everything is learnt for the very first time and memory is being acquired, maximum sensory stimulation is essential for brain development. This is often called the "First Learning Stage". At this stage hearing levels <u>are</u> related to the development of Auditory Perception. Later, when Auditory Memory has been acquired we only need sufficient hearing to enable us to recall what has previously been learnt. Shannon's Law of Information (Whetnall and Fry, 1964) suggests that only 50% hearing is necessary for this purpose. This is clearly shown in the case of the adult who becomes deaf without losing the power of speech and such musical geniuses as Beethoven who continued to compose long after he became severely deaf. Both have memory to depend on. The work of Agnew (1922) would also support this statement.

A study of the relationship of Hearing Levels to Instrumental choice is particularly relevant although it can only be used as a pointer to further research, since the lack of early objective records made the setting up of a controlled experiment impossible. At that stage 105 Junior Students (under 12 years of age) had audiograms made. These were compared with the teacher's records of their instrumental progress. There appeared to be a very definite relationship, i.e. audiograms of successful violinists and flautists could show a hearing loss of up to 30 dB over the frequencies 250 Hz to 500 Hz but anything more than 10 dB loss from 2 000 Hz upwards affected their intonation and tone quality. The following photograph showing the spread of harmonics 0 to 4 000 Hz of a Violin Tone would show the frequency range of the particular instrument which could affect intonation and tone quality.

Vertical 0 = 4 000 Hz. Horizontal 10 seconds.

With bass instruments, a 20 dB loss appeared sufficient to delay the development of good intonation and tone quality by up to a year, with 30 dB preventing learning from taking place at all. With established players however, several successful players were found with hearing losses of up to 30 dB (with occasionally a further 10 dB in one ear providing it was the nearer one to the instrument) at the time of measurement without it affecting their performance.

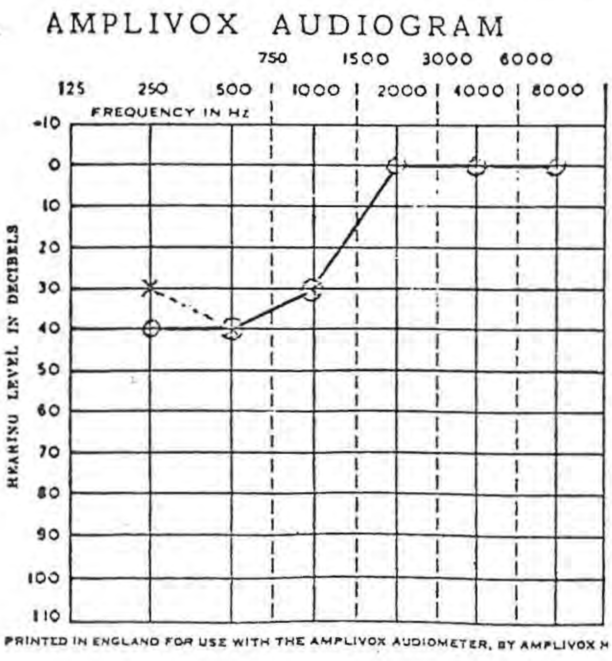
These were all over 28 years of age at the time of measurement, there was no record of earlier audiograms and they were members of a professional Symphony Orchestra.

The recent research into the noise damage to their hearing, suffered by sections of a Symphony Orchestra, is a further illustration that actual hearing levels at the time of testing (providing it is post-puberty) bears little relationship to auditory perception which is concerned largely with auditory memory. (R.O.Jones & R.Pracey.)

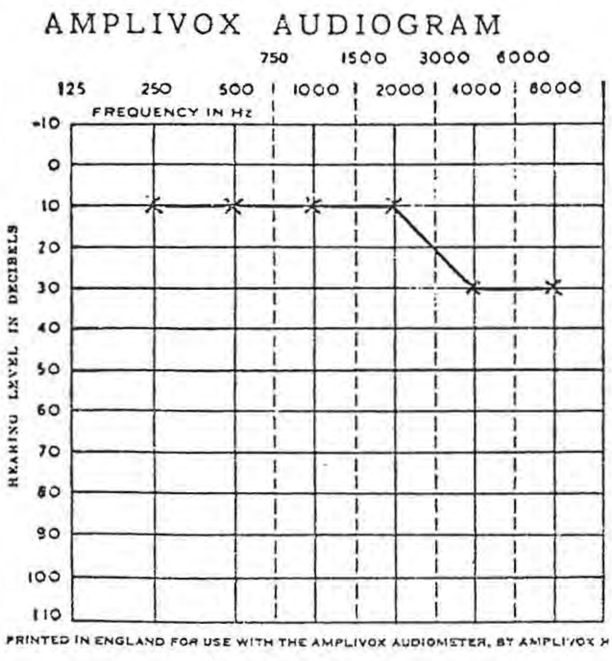
Auditory Memory and Auditory Discrimination are two different functions.

<u>Possible Relationships between Hearing Levels and choice of Musical Activity</u>

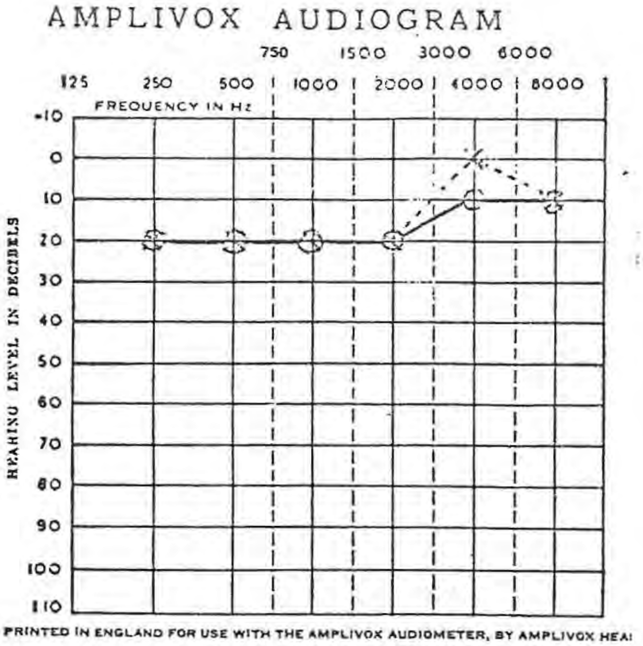
The 11-year old pupils at Cholderton College spent one year trying out various instruments before choosing their second instrument. I then compared their choice with their audiogram. The two most striking examples are given below:



The Violin



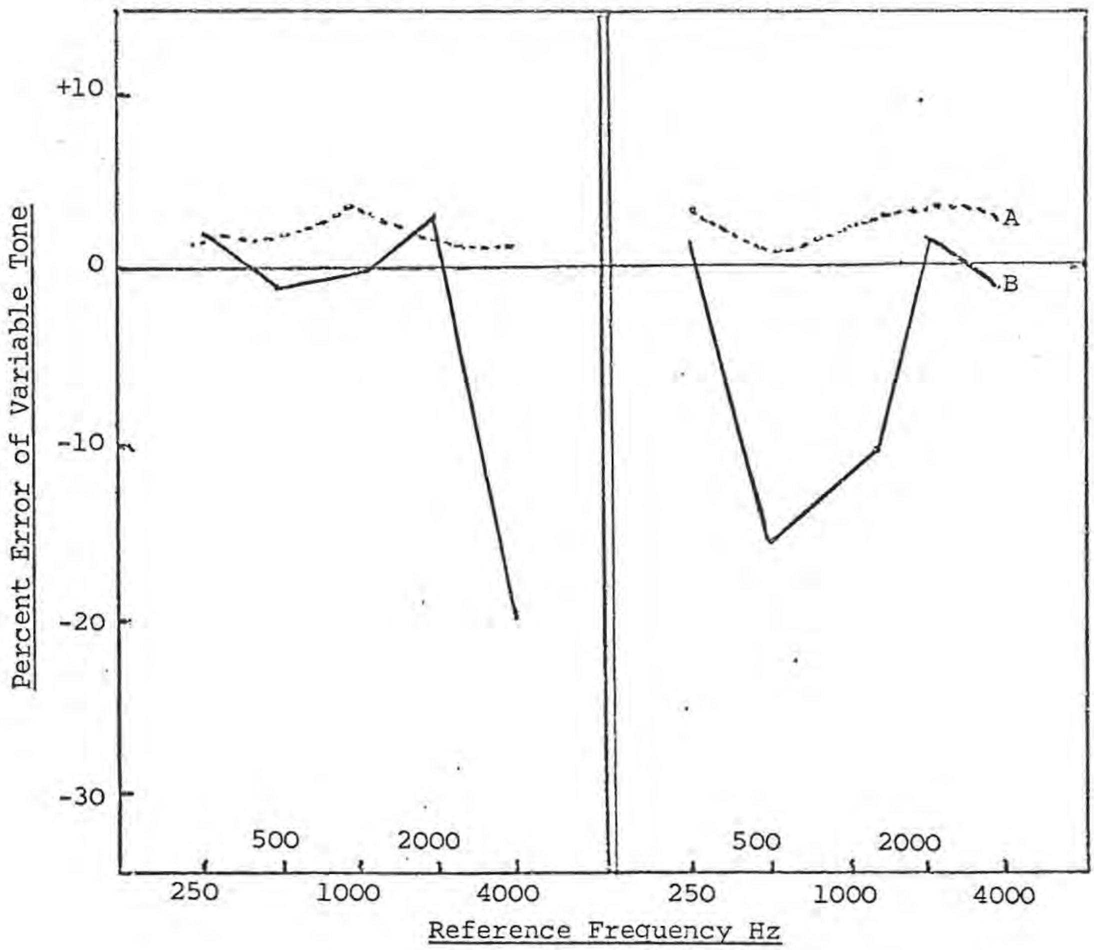
The 'Cello



Harmonic Dictation

This was the kind of Audiogram found among several students having difficulty with harmonic work. Many of them had been about a year late in learning to speak. This kind of loss for the low frequencies did not appear to affect their sensitivity for tone quality, which was often their strongest ability. The importance of the lower frequencies being of sufficient strength is further illustrated by the poor intonation that is often shown by the upper parts of a S.A.T.B. choir if the bass line is weak.

The investigation by Jones & Pracey set out to study the effect of prolonged high intensity sound on the normal ear. Twenty music students were examined by pure tone audiometry and for pitch discrimination, using the Bentley Tests (Bentley, A., 1966), before spending a day in orchestral practice. The tests were repeated after two periods each of three and a half hours' practice. Two woodwind players, seated in front of the brass section sustained unilateral temporary threshold shifts in excess of 20 dB at a frequency of 4 000 Hz. At this frequency one player however recorded sharpening of pitch at 500 Hz and 1 000 Hz where no threshold shift was evident. These findings are shown in the following diagram:

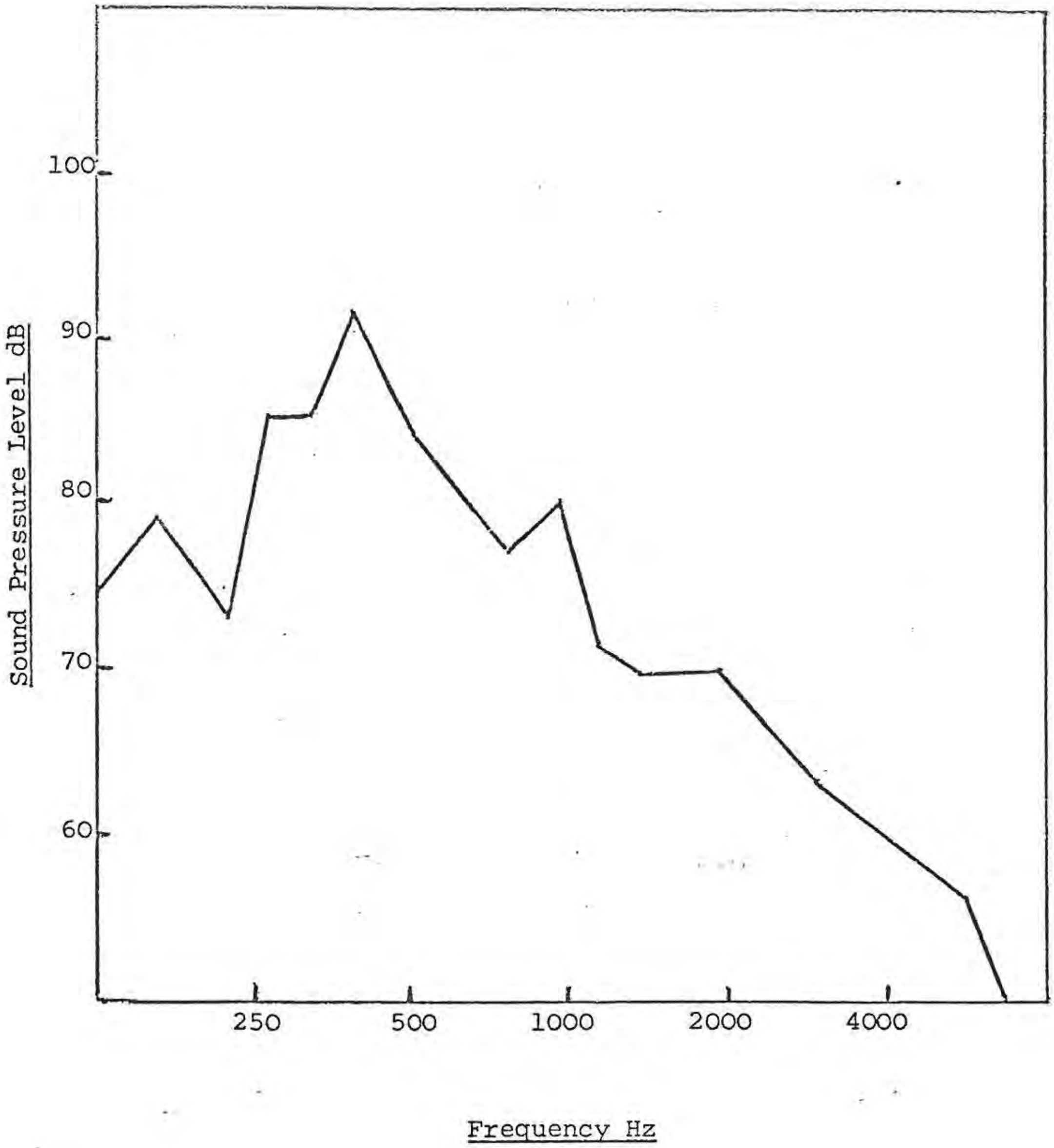


Pitch discrimination of two music students

A. Before Orchestral Practice.

B. After Practice session.

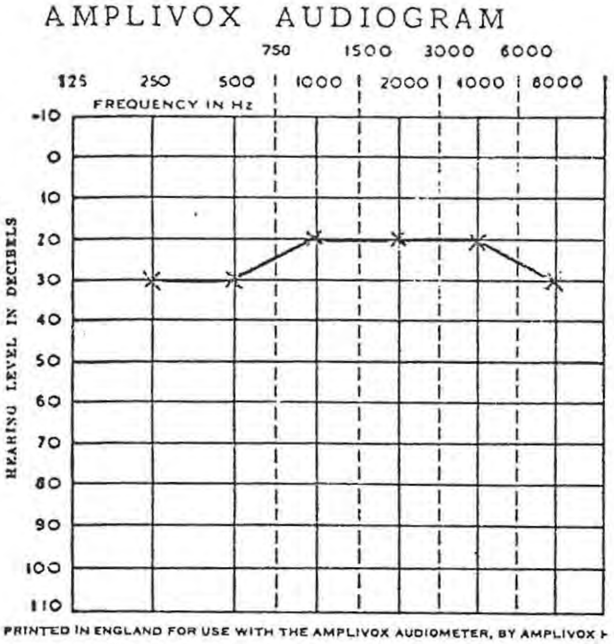
The average sound level of the orchestra was 88 dB rising to 99 dB during the loudest passages of music. A frequency spectrum of the orchestral sound showed that the maximum intensity was in the frequency range of 160 Hz to 1 000 Hz, as shown in the following diagram:



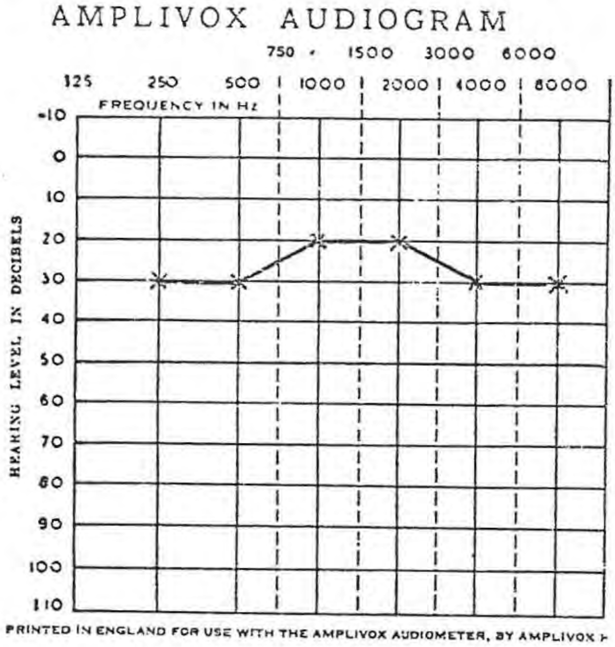
Frequency Spectrum of Orchestra

An Investigation of Pitch Discrimination (R.O. Jones and R. Pracy).

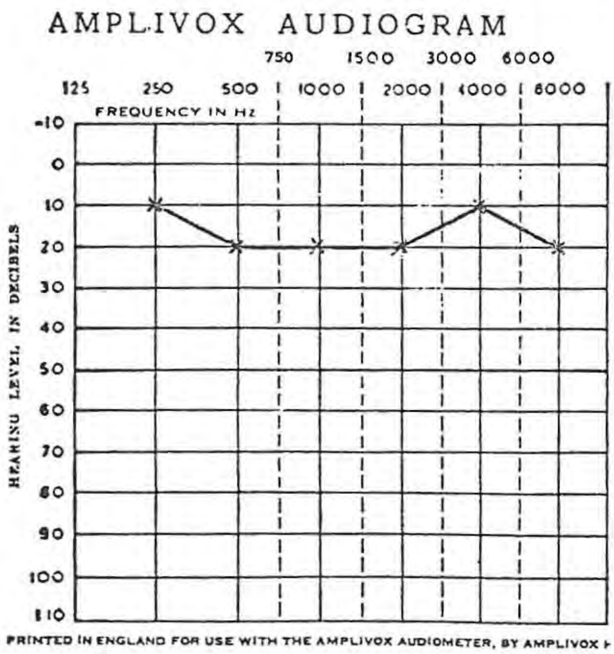
Audiograms of children showing minimal hearing losses which were sufficient to damage the acquisition of Auditory Memory



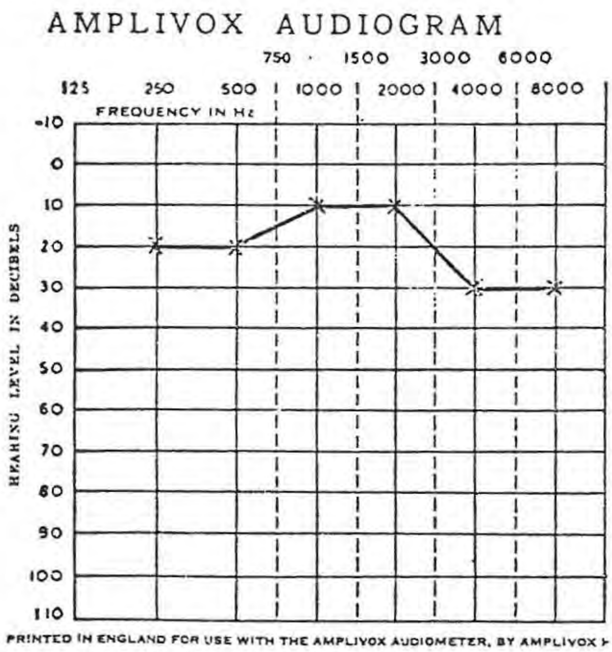
Mark aged 5



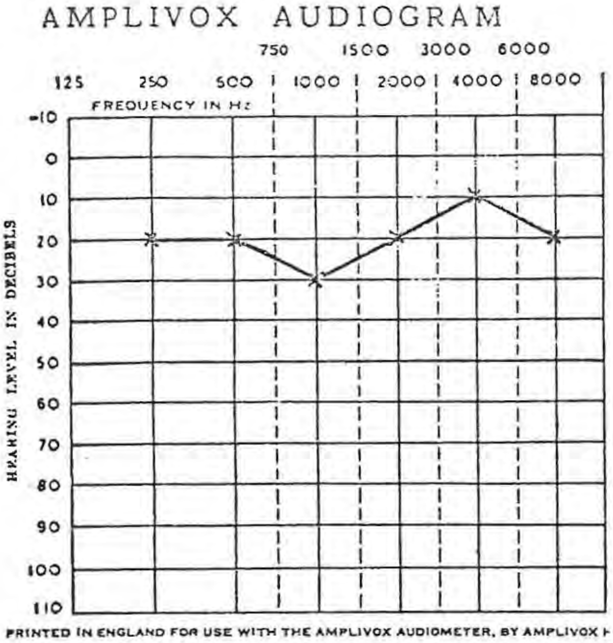
David aged 8



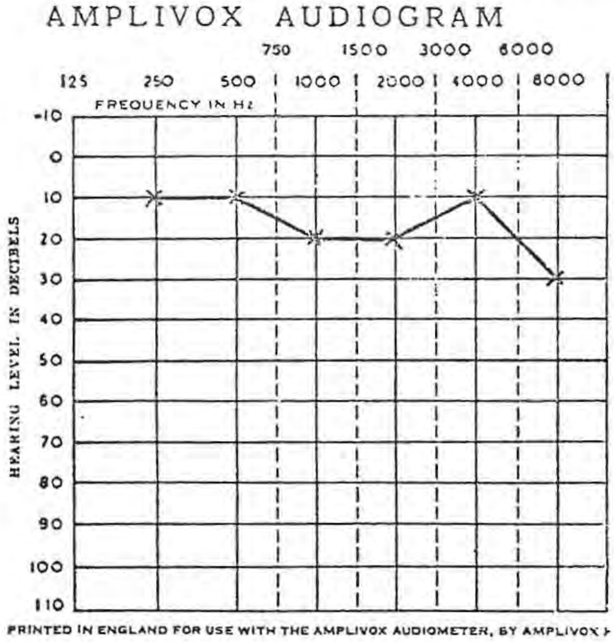
Lesley aged 9



Ivor aged 10



Stephen aged 11



Karen aged 12

The lack of "intensity patterns" in the speaking voice of those with hearing problems illustrates a further problem with this group. As I was concerned at the lack of realisation of just how minimal a hearing loss may be during the optimum years for learning which would prevent an adequate auditory memory from developing, I prepared audiograms of children who were suffering from learning problems arising from an undeveloped auditory memory. While it is true that some children with greater losses than these would, for a variety of reasons develop an adequate auditory memory, nevertheless these children and many others like them, found such a minimal loss a problem. As a group, the children with such minimal hearing losses as these also showed defective eye movement development. The relationship between hearing and eye movement is explained/illustrated in the section "the visual aspect of pitch learning".

In my opinion the pre-puberty child with even the most minimal hearing loss, as measured in routine Pure Tone Audiometry, who is under-achieving in any of the language skills, should be treated as having a hearing loss of 35 to 40 dB and given a hearing aid and regular auditory training.

The reason for this opinion is twofold. First, some exploratory experiments of mine on children have suggested that from the age of three we depend increasingly on auditory memory not only for recall but to aid our hearing. Many workers have shown how a familiar sound is 'heard' at a much softer level than a strange one (Whetnall and Fry, 1964). Simple tests of mine whereby familiar and unfamiliar sounds of the same S.P.L. and frequency range prepared on a tape recorder were presented through a Lenco Auditory Trainer indicated a difference of approximately 35 to 40 dB between the familiar and unfamiliar.

Secondly, as we know, all learning must begin with an initial 'startle' response to attract attention. Once the attention and interest is attracted then it is possible to reach the level at which the sound is actually heard by reducing the S.P.L. in decreasing steps of 5 dB. Tests on these under-achieving, minimal hearing loss children consistently showed the 35 - 40 dB level difference between that required for attracting attention and that actually 'heard' as shown by routine audiometry. We must not forget that the routine Pure Tone Audiometric Tests were standardised on "normal hearing adults". It is therefore possible that children showing even the most minimal hearing loss on these tests actually have the equivalent of a much greater loss when the compensating auditory memory, present in adults, has yet to be acquired.

For <u>first</u> learning, dynamics is clearly a very important factor. Shannon's Law of Redundancy shows that approximately only 50% of hearing is necessary for the recall of material once it has been learnt.

The distortion of intensity patterns arising from a defective cochlea is well understood by Audiologists.

Distortions of pitch, temporal patterns and binaural processing do not appear to be understood; nor the possibility that these distortions can apparently occur with little hearing loss making diagnosis difficult in the very young.

Since music is concerned with these aspects of hearing from the very introduction of the subject at the youngest age possible, defects of the cochlea will quickly become apparent to the trained observer. Musical activities in Childrens Clinics, Nursery Schools, Speech, Hearing and Child Guidance Clinics are surely therefore essential.

Such activities could make possible cochlea deficiencies apparent during these early years, thus causing remedial work to be carried out in order to prevent the deficiencies first appearing as learning failures in the field of speech, reading and spelling, and the various other results of a defective auditory memory.

SUMMARY OF SECTION I

Pitch discrimination is better for long tones than for short tones. A tone must last sufficient length of time to allow the sensation of pitch to be experienced - the length of time increases with age. Auditory fatigue affects pitch discrimination. The child's pitch discrimination ability is more acute in the early morning, fatigue however sets in after about ten minutes training.

Complex rhythmic work can prevent pitch learning, since the duration of each pitched tone may not be sufficient for the sensation of pitch to be experienced. Rhythmic training should therefore be carried out separately during the early optimum years for pitch learning.

The damage to the acquisition of auditory memory by very minimal hearing losses, suggests the possibility that some routine Audiometric Tests are not sufficiently sensitive on young children.

Pitch discrimination disabilities can apparently exist without hearing losses, together with a disability in the coding of temporal patterns.

Training children to listen to the softest sounds they can hear develops listening ability and sensitive intonation.

Hearing problems in childhood can make music an unpleasant or uninteresting experience, resulting in a rejection of music and therefore failure to learn.

Hearing with two ears is more sensitive than with only one ear. During the First Learning Stage, i.e. the pre-puberty years, hearing levels <u>are</u> related to Auditory Perception and the acquisition of Auditory Memory. Later when memory has been acquired, hearing levels <u>are not</u> related, providing of course there is sufficient hearing to enable the activity to take place. Only 50% hearing is necessary for the recall of previously learnt material.

The wave form of musical tones simplifies as the dynamics change from ff to pp until the flute at pp shows a near Pure Tone structure. It must be remembered that there is less learning by children of Pure Tones because these lack interest and information.

SECTION II

FACTORS ARISING FROM LEARNING PROCEDURES

Pitch learning, as with all other forms of learning requires the setting up of a Feedback System. A Feedback System (i.e. the output of the system controlling the system) must be set up before any learning can take place, as the brain must receive information from the output before it can monitor the results and so constantly modify the output. In the case of the Auditory Feedback this is built up by the activation of the speech organs to vocalise. The sound reaching the brain via the auditory mechanism and nerve enables the brain to -

(a) modify the vocalising and become re-stimulated to re-vocalise.

(b) store fresh information together with information gained via the other senses which in turn will affect the nature of the impulse from the brain to vocalise.

In this way gradual control of the speech organs is acquired, and ability to vary them at will, to meet the demands of the brain and match the auditory stimulus. Learning failure appears to be often caused by a failure to establish the necessary feedback system during the optimum period for the development of sensory maturity and so the skills requiring maximum sensory efficiency will remain less than fully efficient. Nowadays however, there is a great deal of equipment capable of assisting sensory development out of the optimum period for normal development, such as Auditory Trainers, Speech Visualisers and Caligrophones. (See section entitled "Vocalisation and Pitch Learning.)

Other feedback systems are involved to varying extents in Pitch Learning:

Visual - Is involved in Relative Pitch Development. (Cholderton, Kodaly, Sergeant).

Tactual - Can reinforce or partly replace the Auditory feedback should the Auditory Mechanism be faulty. (Sarah Munro, Van Uden, Sister Malarosia, Guberina).

Kinaesthetic - Can assist in Relative Pitch development. (Curwen, Cholderton, Kodaly, Steiner).

Motor - Can assist in Relative Pitch. (Steiner, Dalenze, Curwen, Kodaly, Cholderton).

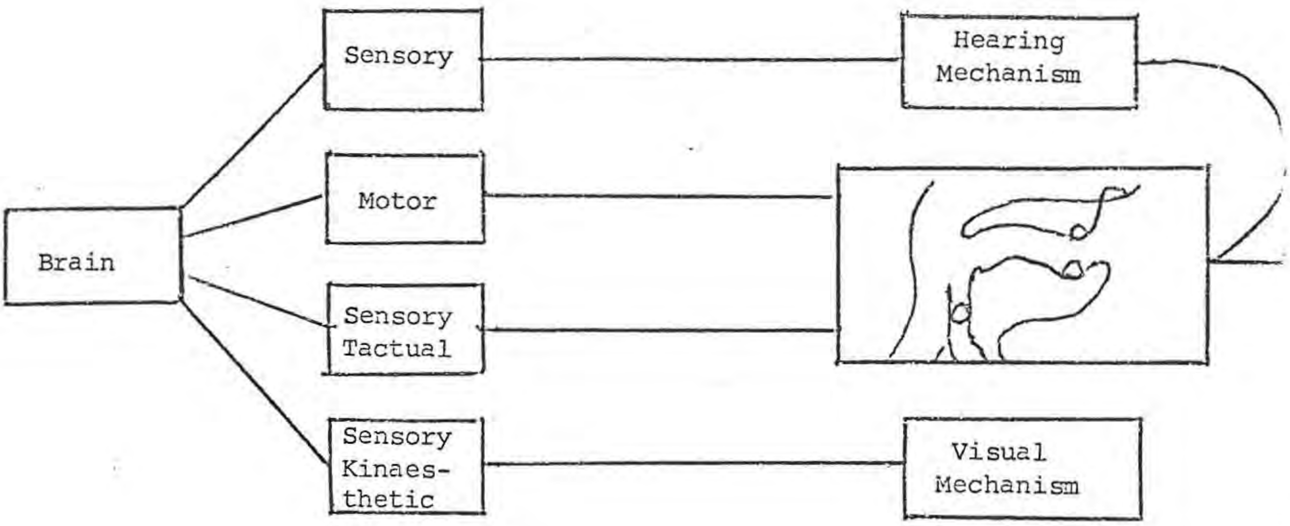
To show the importance of establishing a Feedback System, I have a tape recording showing a deliberate interruption of the system, by getting a subject to read aloud and playing his voice back to him, slightly delayed by the use of a dual channel tape recorder. His difficulty to continue normal speech because the brain waited for information before it could proceed, is clearly demonstrated. (The subject used was perhaps one of the world's greatest authorities on phonetics reading from his own book.) It will be observed also, that by the very nature of a Feedback System, growth spurts of sensory apparatus will cause a delay in the establishment of a system, because of the constantly changing situation waiting for fresh computerisation.

We hear our own voice by air conduction about 1 ms after vocalising. If the feedback is delayed by more than 0,2s then speech is slowed and stuttering occurs. If a normal subject is asked to sing a simple musical scale with a masking noise covering his voice then he sings badly out of tune as the brain is unable to monitor the output.

FEEDBACK SYSTEMS

(Output of systems used to control activity of system).

THE AUDITORY FEEDBACK



Much work has been done to develop substitute feedback systems where auditory feedback is limited, mainly working on vibration sensations, such as the Verbo Tonal Method of the Yugoslav linguist, Van Uden's 'Sound Perception Method', Sarah Munro's work using the piano for teaching speech, Sister Malarosia's work in Belfast - all with sufficient success to suggest that Tactual Feedback can to some extent replace Auditory Feedback. (See also the work of Denes and Pinson, 1967.)

THE VISUAL ASPECT OF PITCH LEARNING

Like G.M. Thatcher in her 'Audio-Visual Integration in Musically Inexperienced Children', I found also that Relative Pitch requires a visual cue for greatest efficiency. Marilyn Pflederer in her paper, 'Conservation in Musical Experience', also found that the presence of a visual cue made a significant difference in the learning of relative pitch. In order to assess the effects of notation on pitch learning and to compare these effects using a variety of notations, a study was made of the history of notation (Wolf, Parish, Apel, Hyatt) and of experimental notations. This was done in a pilot study by comparing the progress of two Grammar school groups of similar age, one in Brighton and the other in York. The Brighton school was taught via traditional notation for three months; the York school were allowed to make up their own forms of notation which they used and developed during the three-month experimental period. The results from pitch memory tests at the beginning and end of the period suggested that any notation providing a visual cue assisted pitch learning providing it was capable of exact definition.

Experimental Notations: To explore experimental notations I studied the work of Wieniaski's 'Izomorph' used in the Polish Krakov Schools, the work of Brian Dennis, John Paynter, George Self, Murray Schafer and finally held a competition for 1 000 children in an East London comprehensive school to invent a musical notation which was simpler than the traditional one, and yet expressed in a musical composition all that was needed to be expressed. Generally the same result was found, i.e. that whereas it was relatively simple to produce symbols to represent 'sound effects' that were easy to interpret, they remained mere representation and it was impossible to prevent variation of interpretation, or to exactly identify pitch without a universally accepted set of symbols that were organised into a system and measured up to the basic criterion for a notation, i.e. one symbol to one response. Any study of language acquisition quickly shows the interference that results from variations of auditory response to visual cue.

It was noticed however, that the result of the competition among the children showed that the time spent exploring the possibilities of alternative notations brought about greater pitch learning among the children carrying out the exploration. This was no doubt due to the great amount of critical listening that went into the exploration, making it a worthwhile musical activity. In considering notation one of the issues is whether to use solmization syllables (and, if so, should doh be fixed or movable?), numerals, a combination of these, or some other way. In my opinion there is a need for a combination of approaches according to the child's stage of development. (See section on the age factor.) These issues are also examined by Dykema, Nye and Van Bodegraven in their articles in the Music Educators' Journal.

LEARNING VIA NOTATION

One all-important function of notation is to provide an objective record, a common denominator for thinking and communication, independent of any theory, style or technique; in fact, a universal language. The creative process in all fields is not primarily intellectual, but once the subtle creative thought has achieved objectivity it becomes subjected to conscious thinking (Professor S. Langer, 'Philosophy in a New Key').

To isolate the effect of notations on pitch learning it was necessary to study a movement notation, since all others were auditory based, and so according to the Law of Facilitation (Sperling, A., 1972), results would be inaccurate when dealing with music notation. I chose the Benesh Movement Notation, i.e. Choreology, as it appeared to fulfil the criteria of a notation. I then studied the results of teaching the notation to a group of Primary and Secondary school children - one in North London and the other in Worthing; the results were similar. The mere act of notating each movement resulted in more clearly defined movements than when the same group of children were introduced to a new movement without the notation. There was also a greater amount of remembering at the next session. According to Cybernetics, it is the act of writing down which organises all known facts and results in greater learning. An explanation of Choreology follows on this and the next page.

Clearer definition and greater learning possibilities is also shown in a study of visual science, as it is shown by Brown and Lennenberg that the codability of colours has been systematically related to colour recognition and memory, and that the more easily objects were encoded the more likely that recognition and recollection took place. Whorf-Sapir hypothesises that this influence on cognition will therefore affect memory. Some experiments with Lennenberg and Roberts, using some Zuni subjects, illustrated how the degree of colour recognition was related to vocabulary, the relation of which was sufficient for accurate definition. They found that the more shades separately identified by vocabulary, the greater the colour discrimination that developed. In my opinion the degree of pitch discrimination is similarly related to notation. This is further illustrated by the phonophotographic analysis work of Carl and Harold Seashore (1934).

Movement Notation based on the Music Stave fulfilling the criteria

of a Notation

HEAD...

SHOULDERS..

WAIST......................................

KNEES............................

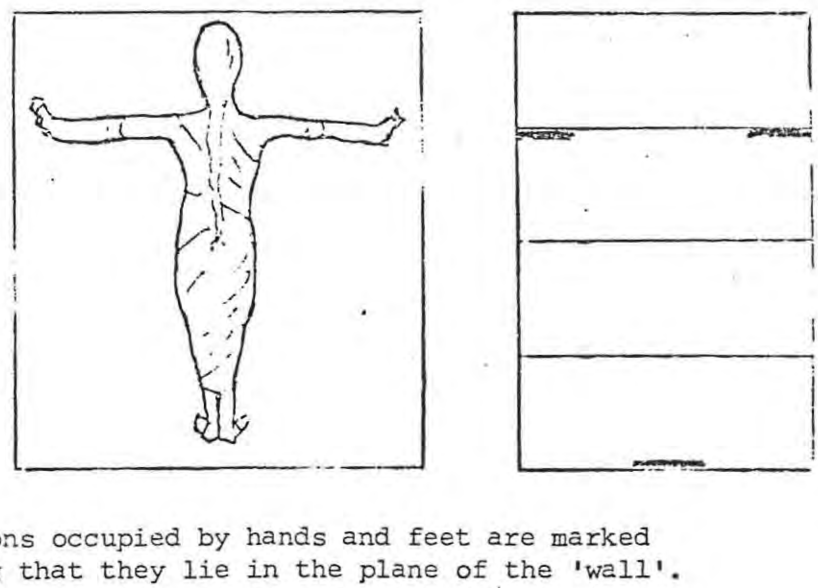
FEET...................

SYMBOLS

	Hands or Feet	Elbows or Knees (limbs bent)
Level with the body	—	—
In front of the body	|	+
Behind the body	•	X

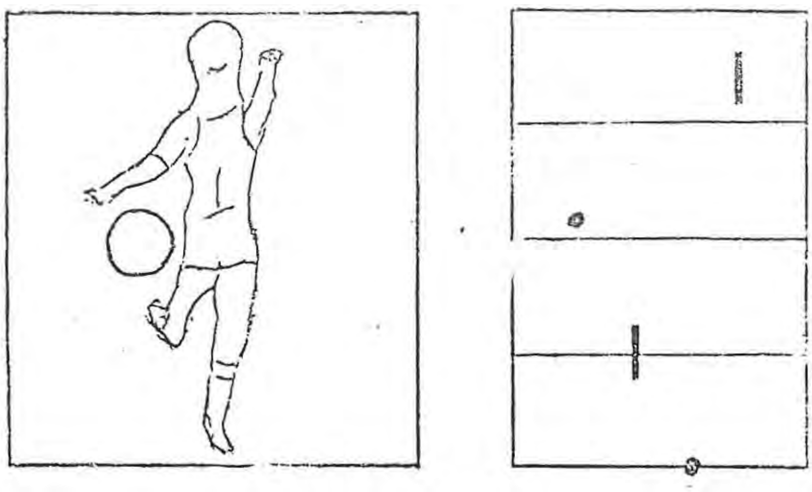
BENESH MOVEMENT NOTATION

The details about postures and movements is visual; simple marks on a matrix (the five line stave as used for music) give a clear visual analysis of the human body, the lines intersecting it at shoulder, waist and knees. The person whose movements are to be recorded is imagined as seen from behind, standing against the five-line stave as if this were on a wall. The positions occupied by hands and feet are marked with dashes, indicating that they lie in the plane of the 'wall'.

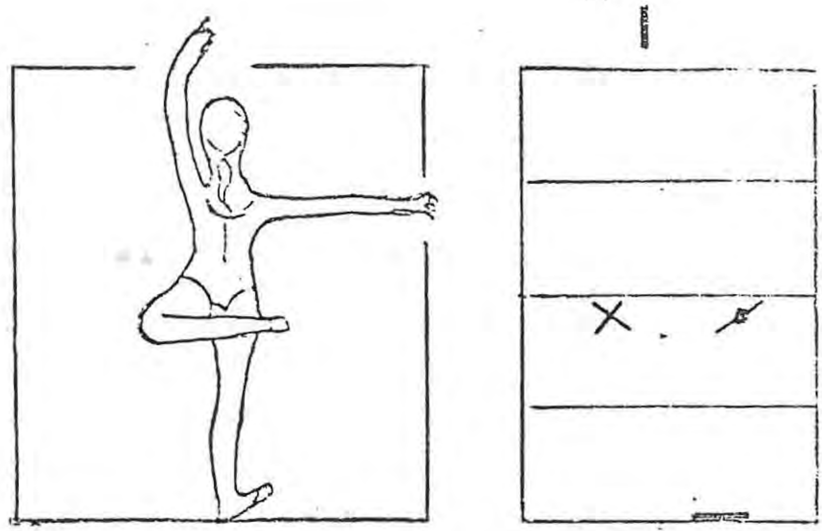


RHODES UNIVERSITY LIBRARY

If the limb extends away from the 'wall' other signs are used- vertical strokes indicating positions in front of the 'wall', dots indicating positions behind the 'wall' - and these mark the projection of these positions on to the plane of the 'wall'.



If the limbs are bent, three further signs (derived from the above signs) are used to mark positions of elbows or knees. The basic alphabet, consisting of these six signs only, can record in a precise and completely visual way any position of the limbs.



	<u>Hands or feet</u>	<u>Elbows or knees</u> (limbs bent)
Level with the body	—	+
In front of the body	|	+
Behind the body	•	×

(Benesh, Rudolf and Joan, 1969.)

VISUAL SCIENCE

Visual Perception is affected by past experience (Gibson (1966), Carmichael, Watts, etc., 1954). What is learned is in terms of what is perceived - what is not perceived can hardly be remembered. Koffhe (1935) emphasises that patterns may be seen and remembered by the arousal of older trace systems. As Hebb (1949) states in 'The Organisation of Behaviour', The first learning of primates is very slow and quite different from that at maturity. There are two kinds of first learning:

(a) The newborn infant;

(b) An adult given his sight after motor and speech development. He at first delights particularly in colours, but before long shows difficulty in effective use of pattern vision. Colour names are easily learned but a long apprenticeship before any useful learning occurs in pattern vision is required.

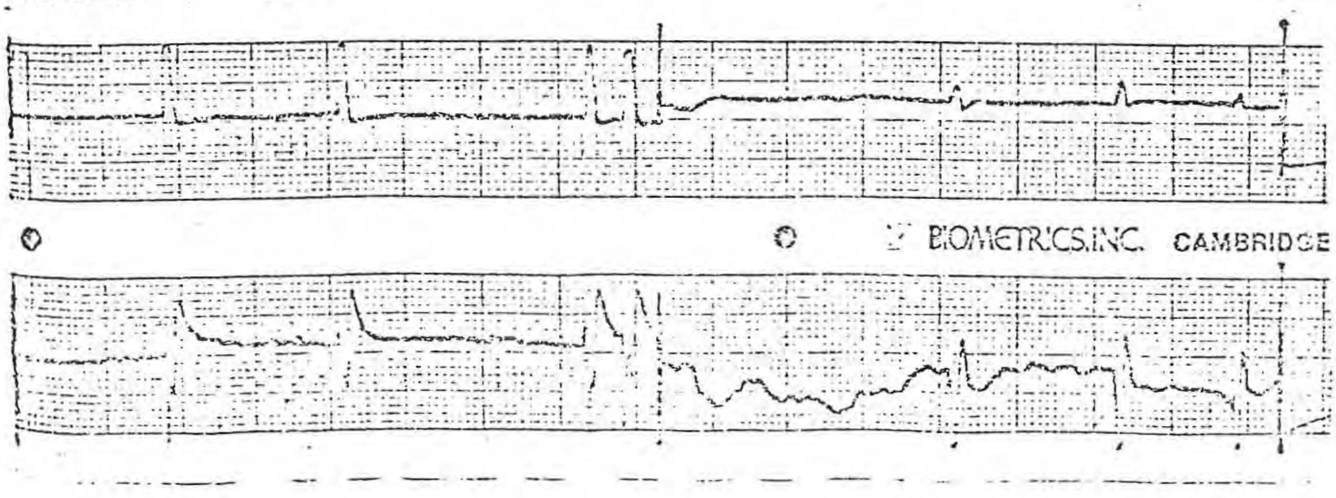
As we move up the phylogenetic scale we find in mature animals increasing ability to learn complex relationships but a slower rate of first learning. A patient after removal of a cataract had learnt only four or five faces after two years, and in daily conference with two people for a month did not learn to visually recognise them. The human baby takes six months to visually distinguish between friend and foe. A long period is required after gaining vision to perceive square, circle, triangle, sphere and cube. The most intelligent and best motivated subject has to seek corners to differentiate between △ and □ - he can often find a difference by comparison between such figures, but cannot remember them. The learning of names for weeks is zero even when tactual recognition is prompt and complete, and there is a difficulty to generalise, i.e. the ability to name simple objects is destroyed if the object is slightly changed or put in a new setting. There are no cases recorded of difficulty in learning colour names. Discrimination of geometric figures is unaffected by brightness relations between figure and ground for simple figures, but the human perception of more complex figures in reversed brightness (as in a negative) is definitely defective. Discrimination between figure and ground develops from approximately three years of age. The perception of ○ and  is possible by three-year old children. Colour dominates form persistently and first vision tests showed that eleven months later colour names were remembered, but form was forgotten.

Riesen confirms that visual perception pre-supposes a long learning period. Sendens tests with man confirmed that perceptual learning is gradual, i.e. it is through a period of separate attention to each part of a figure, to a gradually arrived at identification of the whole, as a whole simultaneously, instead of as a serial apprehension, i.e. counting corners of a triangle before recognising it; about a month of learning is the shortest time even with simple objects. He also confirmed the dominance of colour. Perception is definitely clearer with eye movements as the perception of △ and □ is slowly learned depending originally on a multiplicity of visual fixations.

I then made a study of eye movement in the Visual Science laboratory using a Reading Camera in order to ascertain whether singing or listening to pitched samples in any way affected eye movement, and if so, whether this had any implications for pitch learning, since relative pitch learning appeared to be affected by the number of visual fixations corresponding with auditory stimulus. The act of singing appeared to stimulate eye movement. (See photograph below.) I believe this aspect should be researched more thoroughly, together with a study of eye movement during listening. The child's natural instinct to localise sounds visually served as a further means of developing eye movement.

It was further noticed that when hearing levels had been reduced slightly causing sound to lose its impact on the child and produce the usual inattentiveness and "day dreaming" found in these children then eye movement often failed to mature. Since eye movement is one of the normal startle responses to sounds this is hardly surprising. Eye movement developed <u>before</u> adequate auditory/visual fixations have taken place will produce a careless reader. The training of eye movement as such in isolation will therefore not necessarily influence sight reading but far greater perception is essential.

This is confirmed by the work of Jacobsen, Van Nuys, Weaver, Ortmann, Pietersen, Wheelwright and Bean. The following photograph illustrates the recorded movement of the eyes during a singing lesson:



The effects of colour on the learning of Relative Pitch

The proven dominance of colour over form in learning is another important consideration, made so by Howell's experiment in 1944, in which he taught a group of subjects to relate pitch to colour. A high tone was presented with green and a low tone with red throughout the training period. At the end of this period the subjects were tested by reversing the process. On the sounding of the high tone the colour red was presented, yet it was identified as green. This was further checked by the use of colour filters to establish that it was not merely the naming of colours that was affected. (Hebb, D.O.)

Effects of Listening

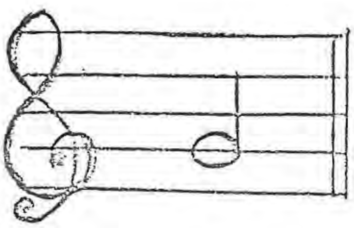
Dr. Patricia Wright's work at the Medical Research Council's Unit in Cambridge, demonstrates the change in pupil diameter when listening. (Wright, P., 1971.)

Visual Fixations corresponding with Auditory Stimulus

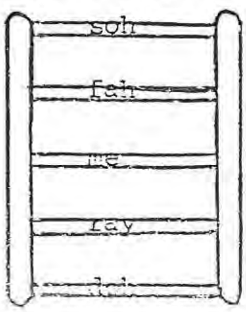
Since the aspect of learning - the field of reading connected with auditory discrimination appeared to take place during eye fixations, I argued that pitch learning would be increased if the Auditory Stimulus corresponded with the Visual Fixation. I therefore set out to verify this, by preparing material for use with a Bell and Howell Language Master which enabled each degree of the diatonic scale to be presented in isolation with the corresponding visual cue. Two forms of visual cue were used:

(a) Staff notation on the stave. (b) Tonic Solfa on the ladder.

(a)



(b)



Thirty children in each group were used of similar ability range, all aged between eight and ten years, and all receiving ten minutes daily in soundproof booths using pre-recorded cards.

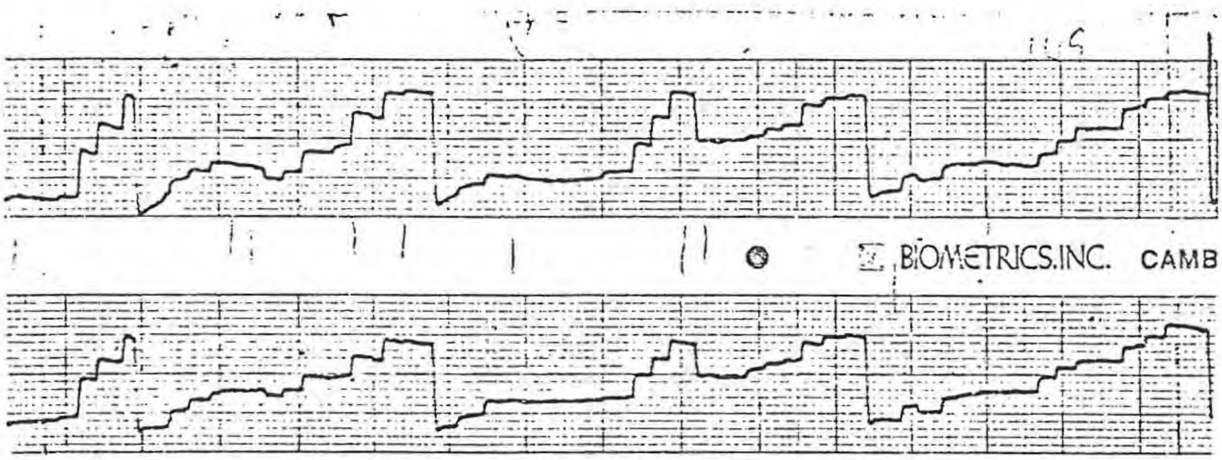
After three months training for five days a week, all the children had a degree of pitch learning corresponding to that achieved by the eighth month in the training programme already described as far as pitch identification was concerned, but some required vocalisation experience before their sight singing was equally accurate. There was no difference in standards of learning between the two forms of visual cue, but greater efficiency appeared to be achieved by the use of headphones with the machines. As one child described it, "the sound seems to go in better and you can't hear anything else".

If Pitch Learning takes place during eye fixation, and not eye movement, in a similar way to the learning of phonics, and the development of the Visual Span necessary for reading of any kind is dependent on the development of eye movement, it follows that separate development of eye movement and eye fixation is necessary. Concentration on the phonics as with the individual pitched sounds ensures learning of those sounds, but does not develop eye movement and can retard such development. Failure to develop eye movement results in readers who identify each word accurately, but read from word to word instead of by phrase, and consequently with little understanding. A similar position occurs with music. Students at Rhodes University with poor sight reading worked through a programme using the tachistoscope which showed individual notes on a screen for the student to identify and play. The speed of presentation was gradually increased. Greatly improved sight reading was shown by the students at the end of a ten-week term. Bean's work supports these findings.

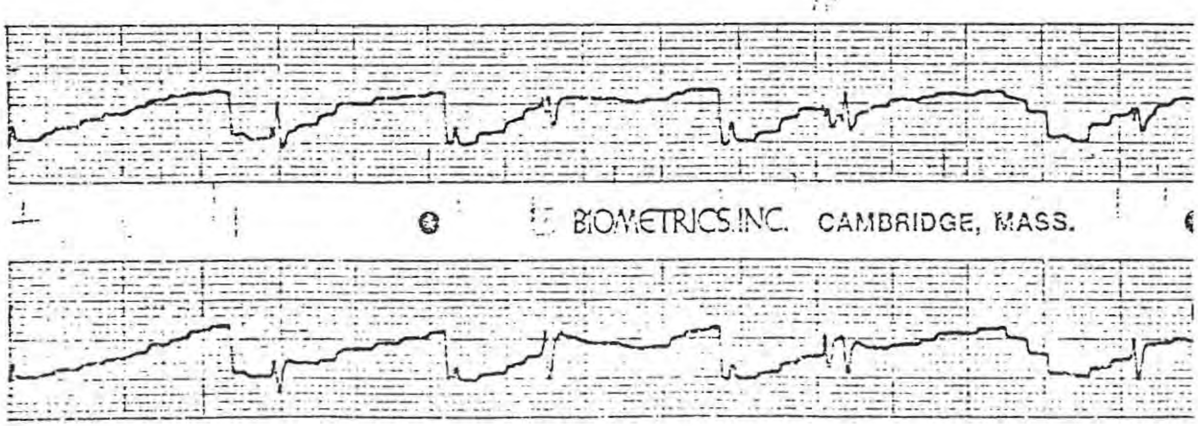
As is the case where any skill needs a great deal of practice before fluency is acquired, and the process of its acquisition can impede the development or acquisition of another desirable skill, it is necessary to ensure that adequate practice of both skills is given separately. Pitch Learning requires great attention to individual sounds, with a great deal of repetition, and training should therefore take place without the distraction of complex rhythms, but eye movement in the reading of music is most easily developed with greater attention to rhythmic patterns, phrases and sentences than to individual sounds. It is suggested that initially pitch work should solely be concerned with the accuracy of intonation and tone quality, and that rhythmic training is better carried out on Orff type instruments, piano, etc. Priority should be given to the pitch work, since the time factor as far as the optimum age for pitch learning is so very short, with the peak being past by seven years of age and well on the decline whereas a similar decline in rhythmic skills is not apparent until approximately eighteen years of age.

Since Visual Cues greatly assist learning, it follows that there is less need for acuity of hearing when there is a visual cue. In the case of the hard of hearing, or those out of the optimum period for acuity of hearing, a visual cue to assist the auditory stimulus is vital, but the constant provision of a visual cue during this optimum period can encourage lazy listening and fail to develop the listening ability to the maximum. It follows therefore that early auditory training should always include some work without visual cues in order to force the maximum attention to each sound without any assistance from a visual cue. 'Aided Hearing' as the provision of a visual cue is sometimes described, can be further illustrated by the improved speech development of a child with a hearing and visual defect when he was given spectacles. Auditory fatigue appears to set in after about ten minutes of such concentrated work. At this stage however further training can usefully continue for as long as a further ten minutes providing a visual cue is used simultaneously with the auditory stimulus. This leads to the development of a Relative Pitch.

<u>Eye movement of a good sight reader</u>:



<u>Eye movement of a poor sight reader</u>:



A Case History of a student who, at the age of eighteen, appeared to develop Absolute Pitch

The student entered the Music Department of a University at the age of eighteen. She played the piano fluently 'by ear', but was totally incapable of reading music. Once a piece of music was played to her she was able to repeat it.

In Theory, Harmony and Aural Training lessons she was failing miserably until it was realised that she could not read music. A special programme was then devised for her with the sole purpose of teaching her to read music. Constant drilling of the simultaneous recognition of auditory and visual cues took place, using at first a language laboratory and later a Tachistoscope. This training was continued for six months. As the student progressed in her ability to identify notes correctly visually, so it became clear that she had Absolute Pitch. This was not therefore a case of someone learning Absolute Pitch at the age of eighteen, but someone who had learnt this many years earlier, but whose inability to identify notation visually had prevented this Absolute Pitch learning from becoming apparent. It transpired that as a child she had constantly listened to her mother playing the piano, and at three years of age began to pick out the melody of what her mother had been playing. By the age of five she was playing the piano 'by ear', but unfortunately was not taught to read music.

Colour and Pitch

J.P. Baggaley in his Ph.D. thesis 'Colour and Musical Pitch', discusses the phenomenon of Coloured Hearing. The importance of his work lies I believe in the words 'the implications of sensory content are handled as imagery; in its turn, imagery affects future perception and is affected by it'. In this way a connection between sensation and imagery is developed and thus learnt. The learning then manifests itself in the phenomenon of synaesthesia.

Many researchers have investigated 'interacting images' between visual and kinetactile sensations and auditory stimulus, and most teachers have used one to suggest the other in order to assist, develop and sharpen perception.

The mere practice of starting from colour, which is normally less ephemeral to the child (out of the Absolute Pitch group) than pitch to explore comparative sensations brought about by pitch, is towards an act of definition. Such an act is therefore bound to assist in the learning of pitch, since imagery would act in a very loose sort of way as a form of notation and all that this implies for learning.

The work of D.O. Hebb and others showing the dominance of colour over shape and form in visual perception, would suggest that colour would affect learning more than notation should more exact definitions be made, and relationships conditioned, during the optimum years for such conditioning. However, Howell's work showing the highly subjective nature of the perception of colour and consequently its unreliability, makes this a highly undesirable approach. His work showing the dominance of tone over colour goes further to explain the danger, as during the course of his experiments it was shown that subjects conditioned over a period of several months to see red when a high tone was played, and green on a low tone, actually saw the colour to which they were conditioned on the playing of the tones even though the colours were in fact reversed. Tests with colour filters showed that it was not merely the colour names which had been conditioned but the actual perception of colour.

I understand from one of the subjects in the experiment that the results were not quite so positive as has been suggested, but that the subjects were all university students and those of a similar age.

In my opinion had this experiment been carried out with children during the optimum years for first learning the results would have been permanent and exact.

Integral Rhythmics (Laura Bassi, 1964) via Rhythmogrammes is yet another way of enabling children to express a component of music, visually.

TACTUAL, SPATIAL, MOTOR AND KINAESTHETIC CUES IN PITCH LEARNING

Tactual, Spatial, Motor and Kinaesthetic cues of the type that could be utilised in pitch learning were then studied. This was done by studying various experiments in the teaching of the severely deaf, via vibration.

Sarah Munro, a teacher of the deaf at the Horace Mann School, Boston, Mass., in her thesis, 'The Piano as an aid to Speech', tells of the use of the utilisation of the sense of touch, explaining that the piano's vibrations are tangible and seemed to serve as a support for pitch in the same way that a hearing person received support when singing with others. She found that a pupil, who had never heard, had often reproduced the pitch of tones more correctly than one who had not always been deaf, and observed that this was probably because he used his powers of observation and attention far more than one recently made deaf, and is therefore better prepared to interpret impression received through the sense of touch. A group of demonstrations described by A. Van Uden in his work with the deaf, further illustrates the use of tactual and kinaesthetic cues for the learning of pitch. (A. Van Uden.)

Ewell Unit for Partially Hearing Children

I found that many children could respond in tune by singing to notes on the piano played considerably more softly than their audiograms showed as their threshold of hearing - the response was also more accurate and immediate than found among normal hearing children. This latter point, I believe to be the result of continual auditory training improving their ability to listen because their hearing loss makes it more necessary to listen. (This was also found by A. Van Uden in Holland.) The difference between the speech of these children and those of normal hearing appeared to be the lack of harmonics associated with high frequency losses, yet all could sing in tune at the frequencies over which they had no greater loss than 40 dB.

In order to establish that pitch learning is aided through the Kinaesthetic system, I chose R. Steiner's work on Visible Speech, and attended Eurythmy sessions to observe and attempt to evaluate the learning possible by the apparent experiencing of pitch in different parts of the body. It was impossible to do any more than make the subjective evaluation, that it did appear to at least reinforce pitch learning. The hand signs as used in the Curwen/Kodaly methods were yet another form of Kinaesthetic experience, and thus reinforcement. Having observed how visual, auditory, spatial, tactual, kinaesthetic cues are all involved in learning, it is perhaps relevant to record an experiment by Socomy Vacuum Oil Company to determine how we learn.

The following results were recorded:

Consideration of how we learn

(Research by Socomy Vacuum Oil Co.)

1% through taste; 1½% through touch; 3½% through smell; 11% through hearing; 83% through sight. Even more important however, is that we retain only 20% of what we see and hear simultaneously, with a further increase of 13% following listening training. The more senses involved in any piece of learning the quicker and more efficient that learning. E.E.G. work however suggests that each sense is capable of the same strength of signal. Geoffrey Keppel of the University of California in a study of 'Forgetting' found that delayed recall on the first test of a session was much better than on succeeding tests but with visually presented material the entire curve was higher than that resulting from auditorily presented material. The degree of reinforcement in pitch learning by kinaesthetic cues is clearly shown in A. Van Uden's demonstration illustrating his Sound Perception Method, an account of which is given in the Appendix.

The work of Leontiv shows how the motor cues in the physical act of vocalisation contributes to pitch learning. Steiner's work, which introduces movement into the learning of pitch, can be seen as a further example of the use of the motor system to provide a reinforcing cue in the learning of pitch. Instrumental experience also contributes to pitch learning, by a similar provision of reinforcing cue by the motor system, in addition to the external auditory stimulus provided by the instrument. There has however been no controlled experiment to assess the strength of reinforcement in pitch learning by the involvement of the motor system although there is some experimental evidence in the work of the "Sound Approaches for Slow Learners" project in Dartington, Devon. This work showed that "the visual, tactile and motor appeal of the instruments were important factors" in the later identification of their tones. Human Motor Performance clearly effects the detection, comparison and judgements of kinesthetic information (Marteniuk, Ronald G, 1976). Sensory Interaction for the improvement of perception is further illustrated by the work of Karlovich (1968).

THE TIME FACTOR IN TRAINING

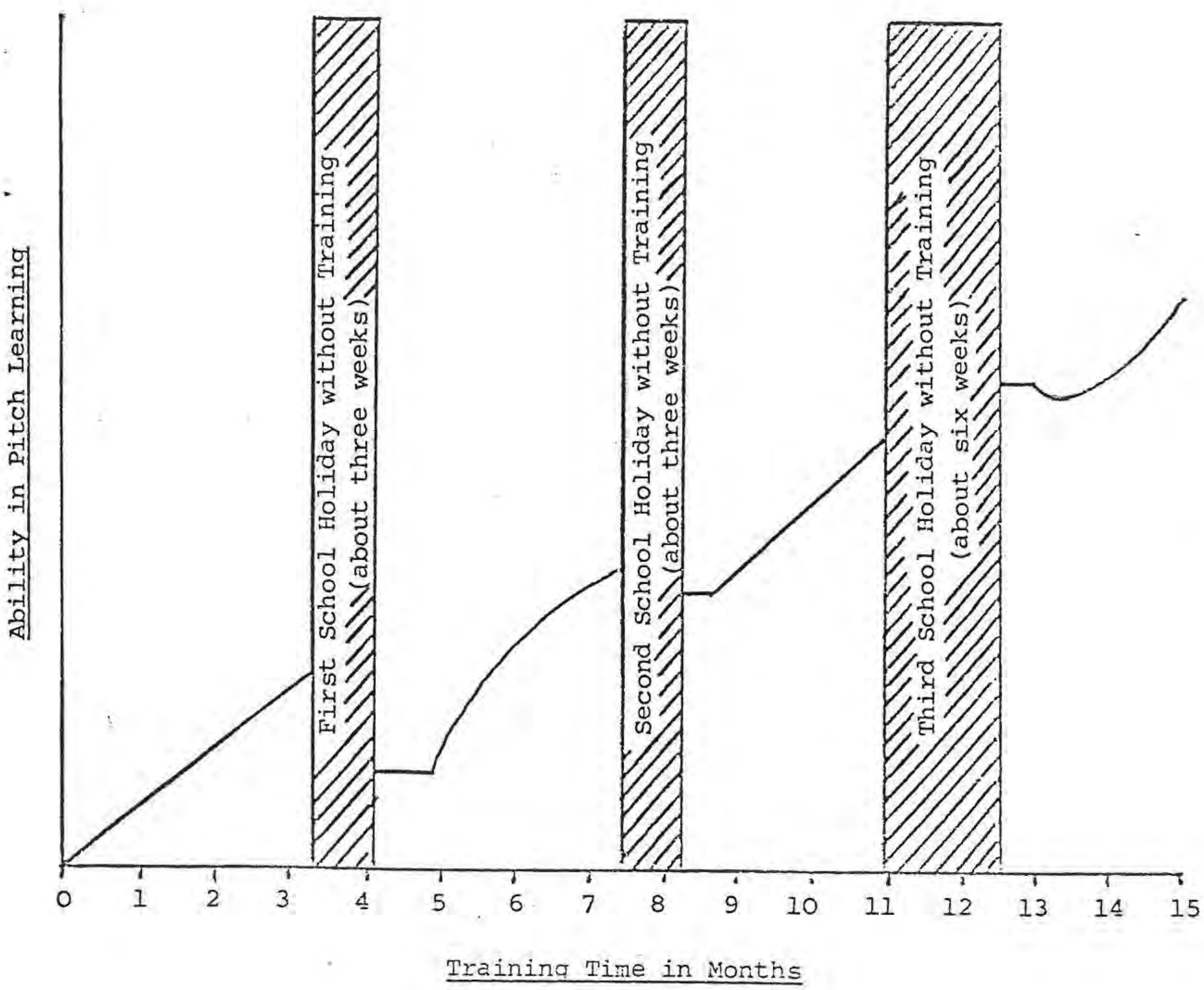
In the training programme used to test the age factor in pitch learning, a copy of which is in the Appendix, it was found that time was another influencing factor. This was shown by the emergence of a regular pattern whenever such a training programme was used, e.g.

During the first twelve weeks of training, pitch learning continued steadily. This period was then followed by a four week holiday from school and therefore rest from training. On returning to school the children were found to have regressed and it took approximately two weeks to reach the standard achieved by the end of the first twelve week period. Progress then continued for a further ten weeks when there was yet another holiday of four weeks. At the end of this holiday the children had again regressed, but this time it took only two days to reach the standard achieved at the end of the second twelve week period. Progress then again continued steadily and by the ninth month from the commencement of the training programme, all the children could sight sing accurately any diatonic melody. At the end of the tenth month all the children went home for the long vacation of about two months. When the children returned to school at the end of the twelfth month, in spite of the longer break from training, two changes only were noticed:

(a) Not only was it found that there was no regression, but the learning appeared to be more secure and consolidated.

(b) The break seemed to have improved at first, the sensitivity to intonation and quality of tone, but this extra acuity faded slightly after about a week before gradually building up again, at which stage the upward curve now became more gradual. Later it was found that the pattern repeated itself with each new annual intake of children.

<u>The Time Factor in Pitch Learning</u>



This training programme was then repeated with each annual entry of pupils over a period of seven years (1960 - 1967 at Cholderton College). The same pattern emerged annually, notwithstanding that some children commenced training at a higher standard than others, even the slowest child had mastered the ability to sight sing any diatonic melody accurately by the ninth month, and that this ability appeared to have been consolidated and more permanent (subject to some reinforcement) by the twelfth month, thus enabling breaks from training for periods up to two months without regression. The same improvement in acuity of intonation following breaks from training at the end of each term of twelve weeks, was found to be a regular feature after the first year of training. The regression prior to the ninth month of training also continued to occur in each intake. It would therefore appear that a period of a year is significant in the learning of pitch. Experiments to assess the number and length of training sessions each day, and then each week, to achieve the maximum results produced the following information:

(a) Varying the length of training sessions from 20 minutes to 30 minutes to 40 minutes, produced little difference in pitch learning; an overall time of one year was required in each case.

(b) Less than 20 minutes daily slowed down the initial learning and affected the reliability of pitch memory achieved by the end of the year.

(c) More than 40 minutes caused boredom and the pitch discrimination became less accurate.

(d) Once the year was completed it was possible to reduce the number of training days per week from five days to four days, without affecting the standard of intonation. It was found that more than five days a week training did not increase the pitch learning; a minimum of five days a week training however was necessary to allow the pitch learnt to be consolidated in a period of one year. Less than three periods a week did not provide sufficient reinforcement for the pitch memory until after puberty had set in.

(e) More than one session each day helped the slower ones to achieve the ninth month standard, but afterwards produced little change - one year was still the time required for consolidation. It was also found that the ability to learn through hearing gathered momentum with training, providing the hearing level was adequate. Dr. Suzuki's work with his young violinists reinforces this observation; he found that one child required 3 000 listenings before he could accurately repeat his first phrase on the violin, but the second one only took 150 listenings and thereafter followed a decrease in the number of listenings. A further consideration of the maxim 'sufficiently often' is given by John Blacking, the anthropologist, in his essay 'Towards a Theory of Musical Competence' wherein he refers to the opinion that black South Africans are considered to be more musical than the white, but comments that what is not noticed is the amount of rehearsal and critical listening that precedes and accompanies performances. He goes on to describe musical competence as being 'generated and stimulated by some or all of the basic animal drives of self preservation, reproduction, co-operation and exploratory behaviour'.

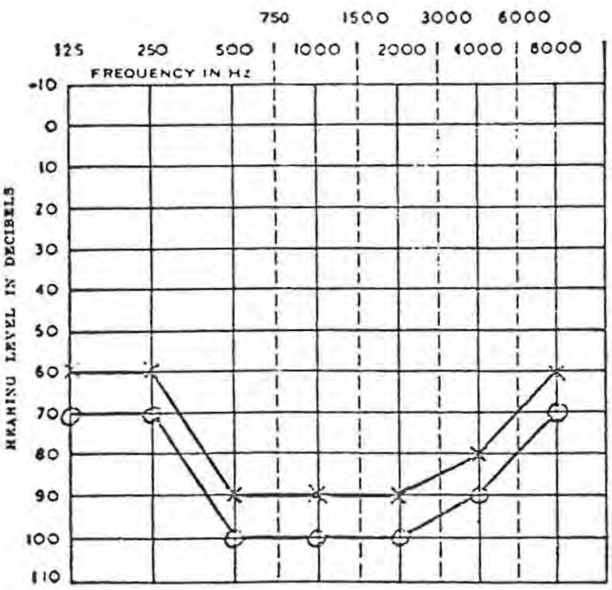
'Sufficiently loudly, sufficiently often' during the first three years of life is, according to Dr. Whetnell's work and many others, the criteria for learning through one's hearing. Dr. Eva

Frommer, psychiatrist in charge of St. Thomas's Hospital, adds, 'sufficient stimulation to evoke response' and quotes the number of children who have failed to learn to speak, albeit they had normal hearing, merely because they lacked sensory stimulation.

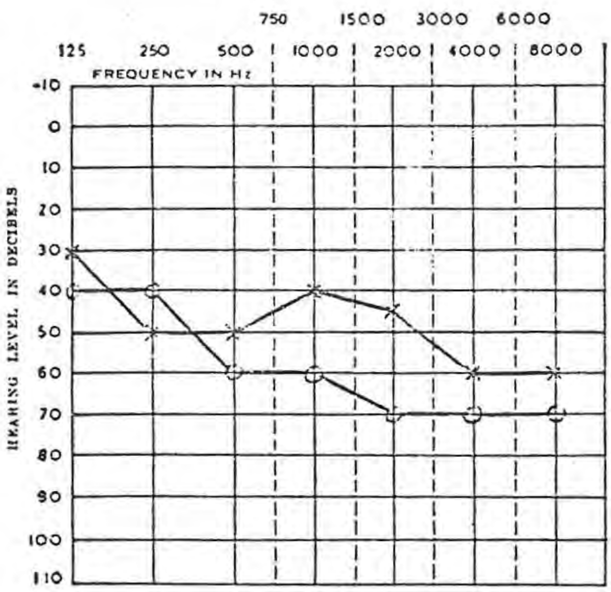
Dr. E. Whetnell found in her work at the Grays Inn Road Hospital that it took approximately one year's auditory training to turn the survival hearing with which we are born, to listening, which includes comprehensive hearing or perception, and that the level of hearing without perception became the level at which perception was possible after training.

This is illustrated by the three sets of audiograms below, showing the changes as a result of auditory training.

(1) P.B. ; 1946 ; age 3½ years. Diagnosis - subtotal deafness. Castanet three feet loud voice meatus. Training of hearing recommended.

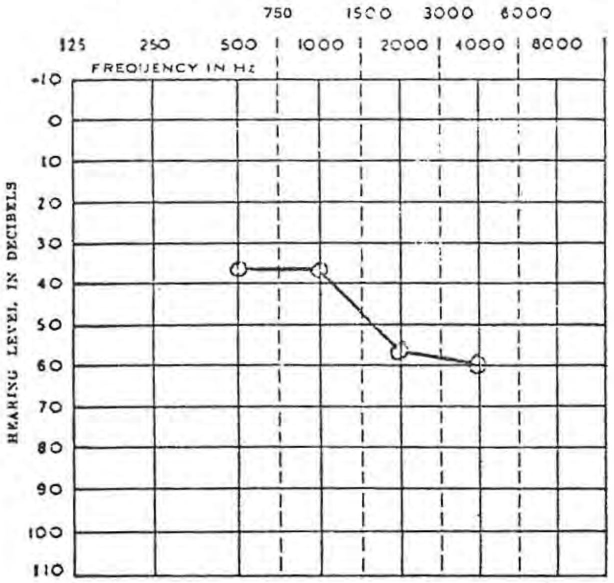


1947, age 4½ years. First audiogram after one year of training. Vowel hearing meatus.

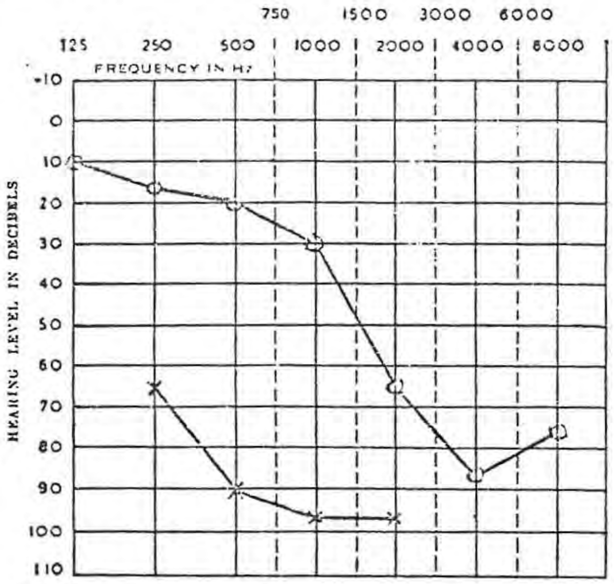


1948, age 5½ years. Can understand speech in right ear at 1½ feet unaided and 5 feet with an aid, without leap reading.

(2) K.B. ; 4.7.48. ; 1950 ; Meningococcal meningitis (18 months).

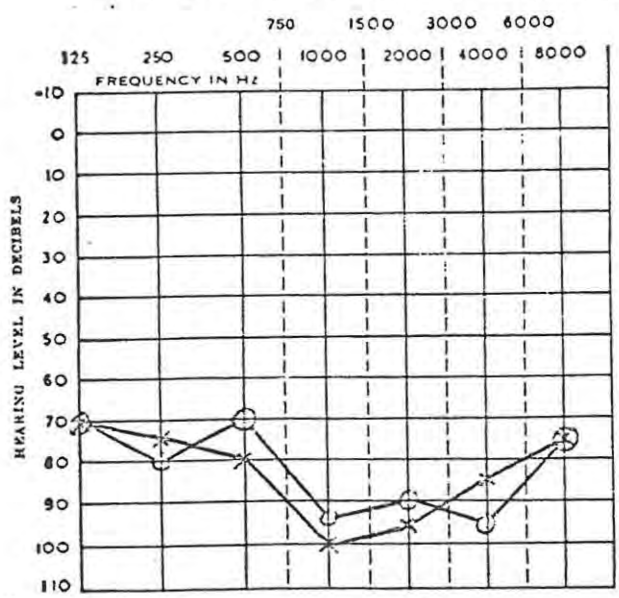


1952 - first seen. Hearing right ear, nil. Left ear, vowels three feet, consonants one foot.

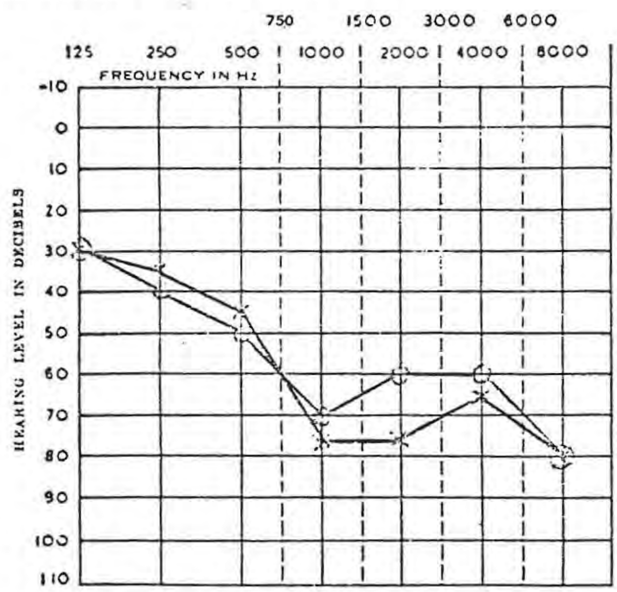


1957 - In ordinary school, good report. Conversational voice, hearing two feet or words and sentences. Since then progress has continued to be good. Mixes well.

(3) S.L. ; 10.6.47. ; Congenital deafness - cause unknown.



1952 - Hearing aid issued. Vowels heard at meatus right ear and at one foot in left. In ordinary school by 1954. Making progress in auditory training.



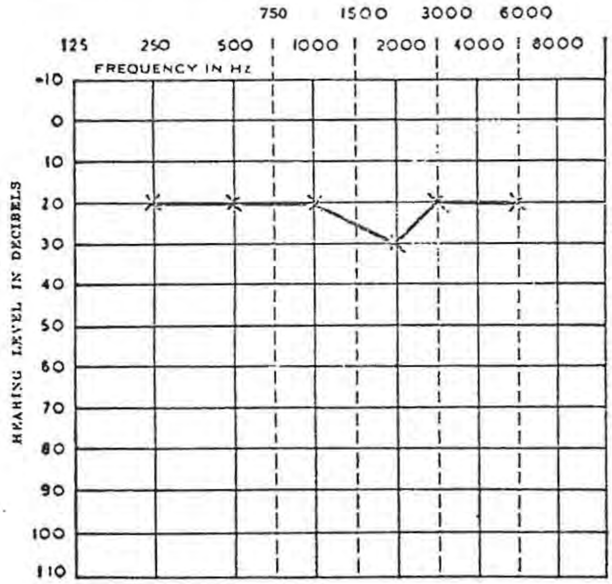
1955 - Hearing simple sentences at meatus. Comprehension now good. This child made a late start, it took her 3 years to learn to hear from the date she received her aid.

The above audiograms are according to Whetnell and Fry.

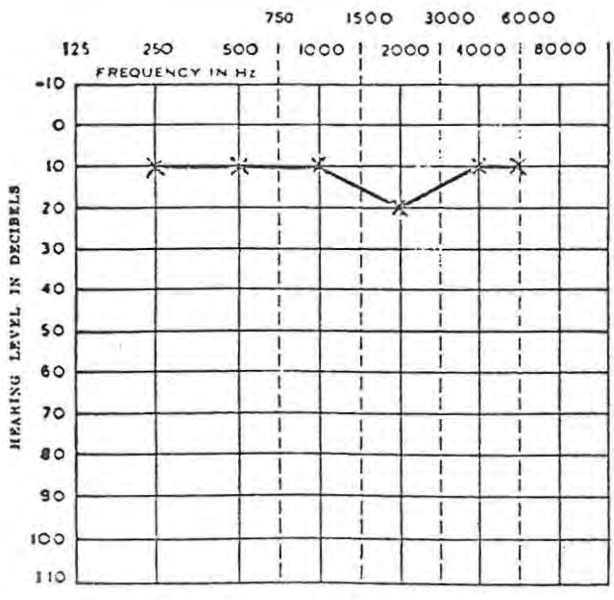
THE EFFECTS OF TRAINING

The effect of training was shown by the shift in Auditory Threshold after training periods. This is illustrated by the following Pure Tone Audiograms made on one subject. A possible explanation of the shift in threshold is the fact that a familiar sound requires less hearing to recognise than an unfamiliar sound.

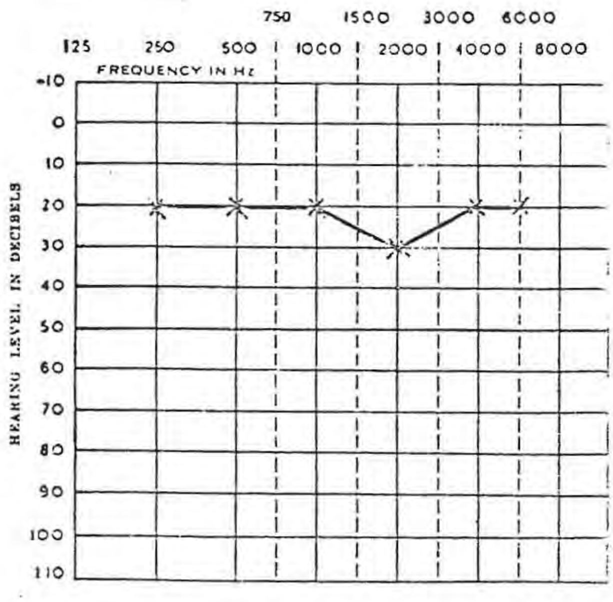
Auditory Threshold before Training



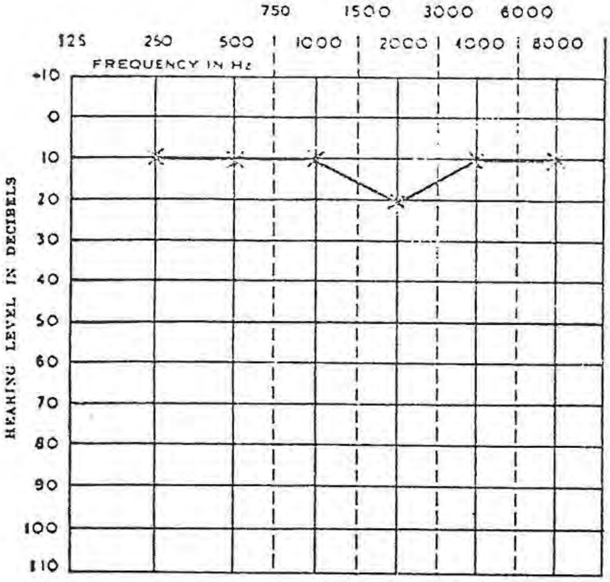
Threshold after ½ hour Training



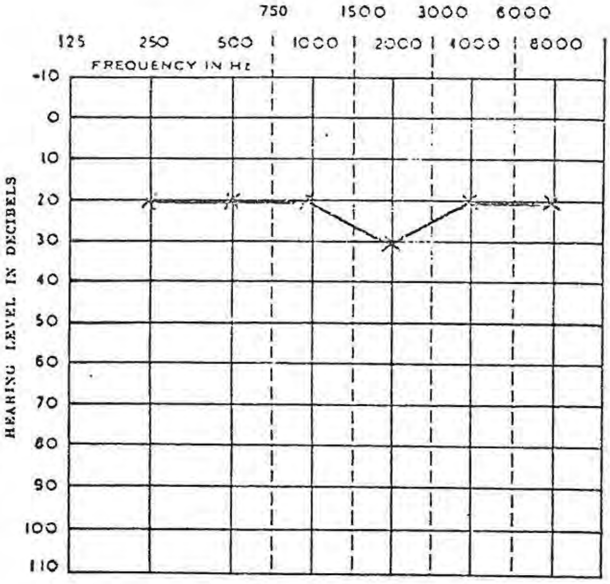
After one night's rest



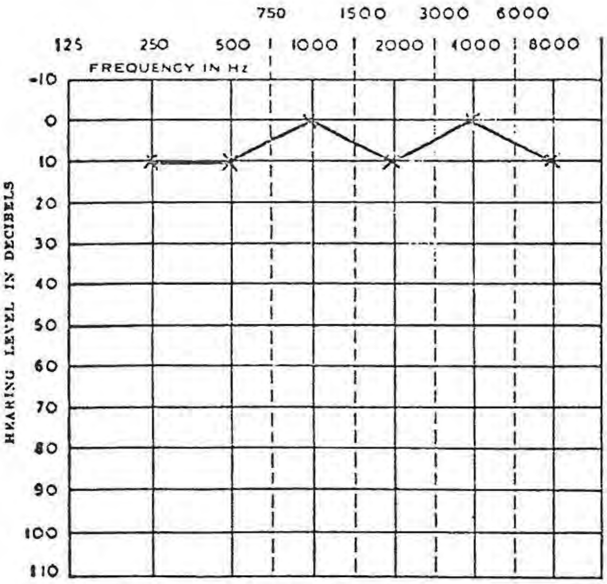
After ¾ hour Training



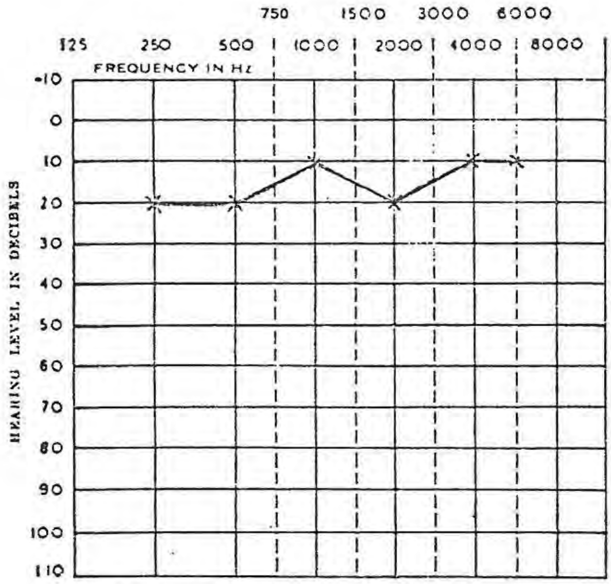
After 1½ hours rest



After 1½ hours Training

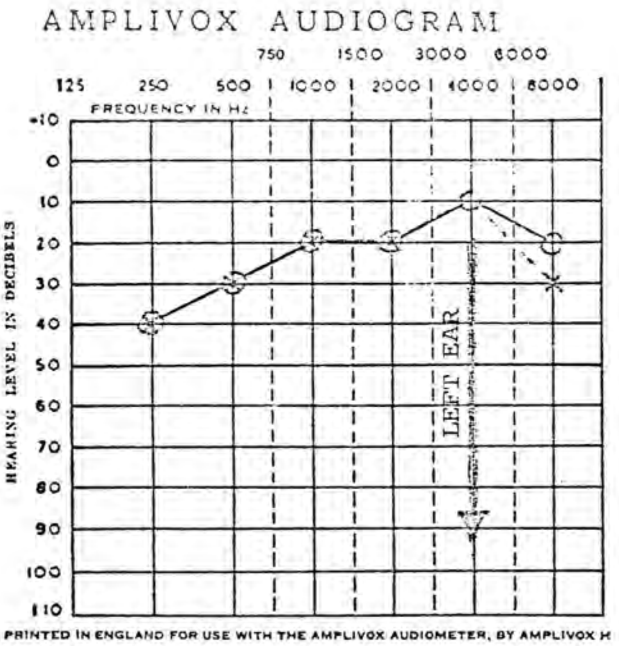


After one week of Training



Effects of Training on one child, aged four years

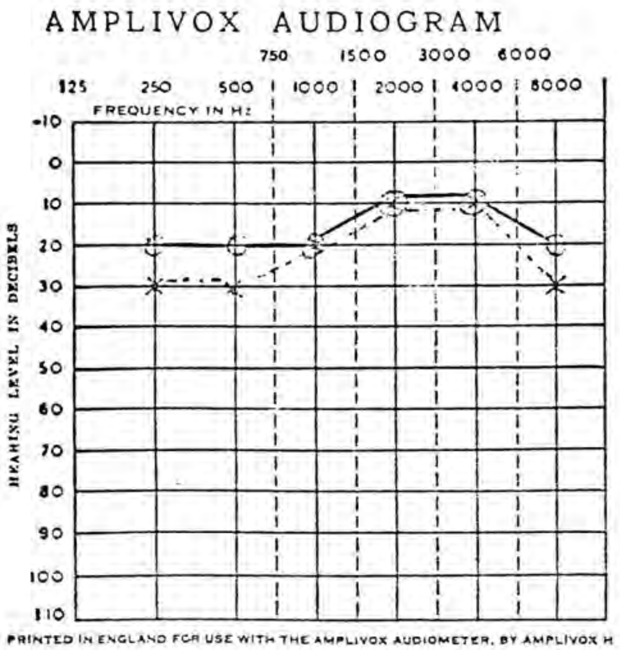
A four year old child was tested and found to have a 60 dB dip in his hearing at 4 000 Hz, as if suffering from noise damage; shown in the audiogram overleaf labelled 'Before Training'.



Before Training

Investigation showed that he had been placed in an incubator for the first days of life. Would the noise of the oxygen 'hissing in' to the incubator at approximately 65 dB have been the cause?

A Nursery School teacher gave him twenty minutes listening therapy a day on a Linco Auditory Trainer. In six months the dip at 4 000 Hz was reduced; see audiogram below labelled 'After Training'.



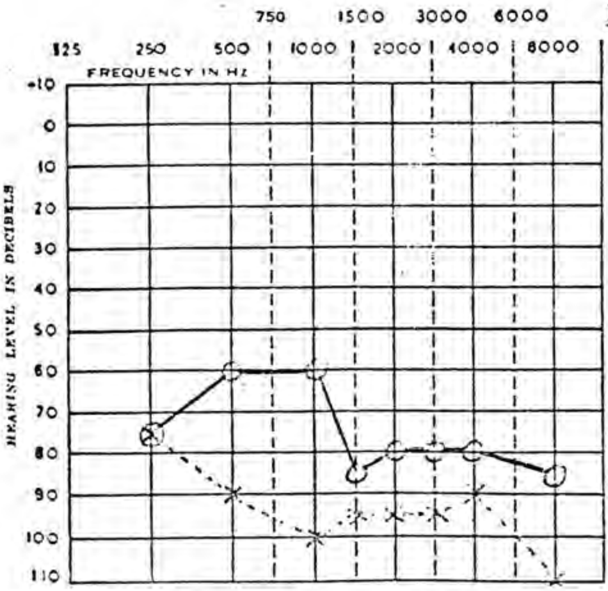
After Training

Is noise damage in the cortex? Was this rehabiltation the result of the great plasticity and vicarious function of the young child's brain? This very plasticity making relearning so possible, explains the great need for a stable learning situation during these early years of great plasticity. Sergeant found that one of the young Absolute Pitch subjects lost his learning of Absolute Pitch when the piano in the house was changed.

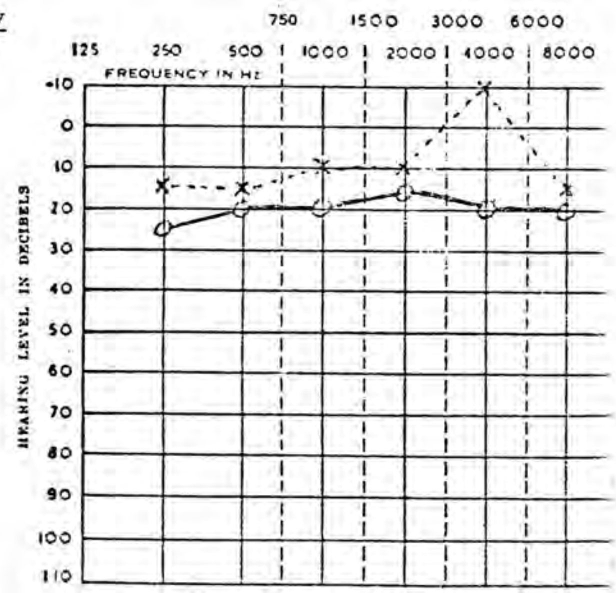
I believe that many youngsters have failed to learn Absolute Pitch, not because of lack of music in the home, but because of multiplicity of pitch samples during this age. The position appears to equate with the child expected to learn several <u>first</u> languages simultaneously.

The age at which training is given appears to be the deciding factor in obtaining changes of auditory thresholds. The following audiograms would appear to illustrate the difference between the effects of training on a pre-puberty subject to that on a post-puberty subject. The audiograms were collected by an electronics engineer.

Pre-Puberty

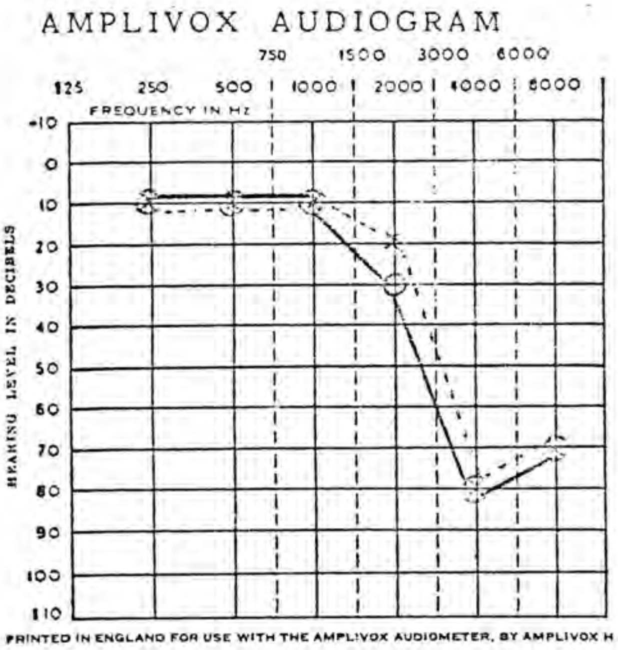


Commencement of Training
7/7/72. Aged 9 years.

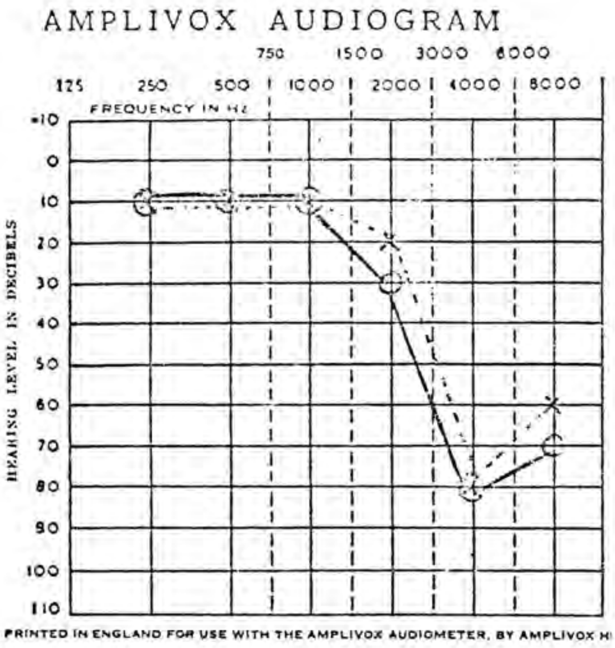


After one year's Training
4/7/73. Aged 10 years.

Post-Puberty



Commencement of Training at Post-Puberty stage.



After one year's Training.

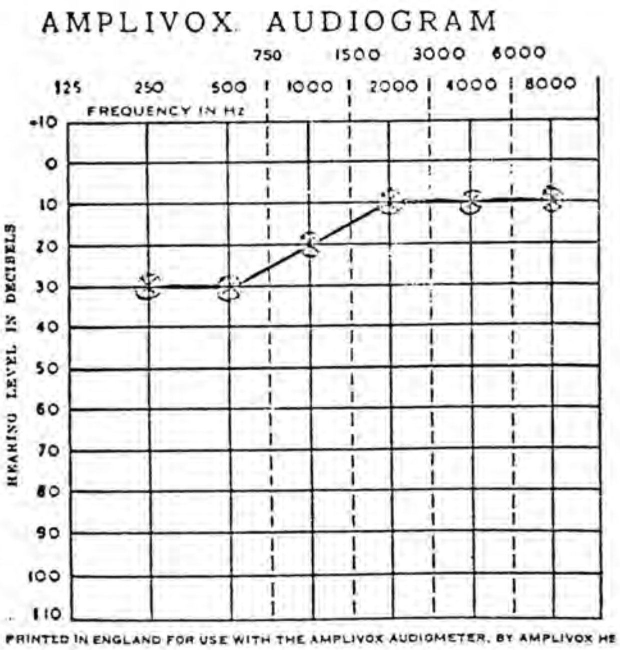
In spite of the above audiograms however, such evidence of the effects of training on actual hearing levels is far from conclusive, since a detailed study of the background of the subjects was unfortunately not made. A superficial study of the background of the children recording the most startling changes in threshold often revealed conditions of mental strain at home or at school caused by such factors as broken homes, unusually impatient teachers, etc. Clearly therefore 'hysterical' deafness cannot be ruled out.

A slow response to sound arising from general low ability would also be changed with training and added impact from amplification and so produce an apparently startling change in threshold.

The effects of minimal hearing losses on the eye movement development necessary for reading and therefore general intellectual development could be yet another inhibiting factor.

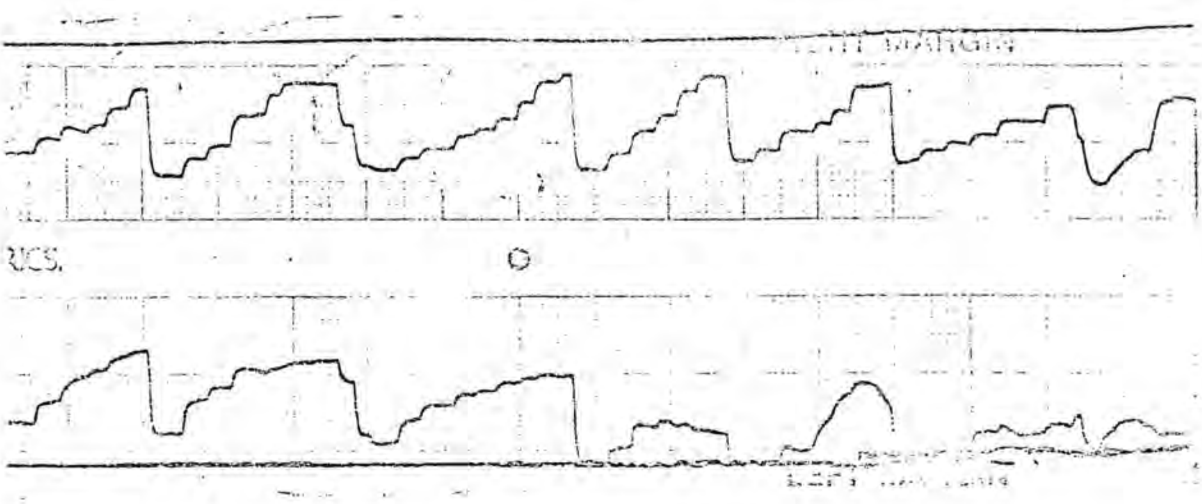
Children showing a minimal hearing loss during the first six years of life appeared, as a group, to have an undeveloped eye movement. In my opinion the explanation lies in the fact that the child's response to sound is initially a startle one, with the child localising the sound visually. A reduced hearing level would deprive the child of sufficient practice in such localising with its attendant eye movement. Thus, unless remedial action is taken, immature eye movement can become a possible side effect of a reduced hearing level during these early years. This could result in poor sight reading in music and any other form of reading.

The relationship between early hearing levels and eye movement that I have repeatedly found in children with learning problems is illustrated by the following audiogram and eye movement record of a nine year old boy.



The six children with minimal hearing losses shown on pages 41 and 42 all were subjected to Eye Movement photography. In each case there was immature eye movement similar to that shown on the follow-

Eye Movement Record



A Pitch Learning Abnormality showing the need for reinforcement

I found a teenager went into a deep coma whenever Bb was played. This first showed itself when a school buzzer for a lesson change was installed, and later found to buzz at this pitch. The same girl also found that some hairdryers produced this pitch and tyre noise at certain speeds also had an element of Bb. Whatever the source of the pitched Bb, a deep coma followed. Eventually the cause was tracked down to the fact that in early years she had had a great deal of surgery at regular intervals over the years. The anaesthetic machine buzzed at Bb and so she had learnt to slip into a coma at this pitch.

It was only by taking care to avoid this pitch that the problem was overcome. This took four years of avoiding the pitch to prevent reinforcement of the learning and to allow for it to be forgotten. In my opinion this case is of value in that it shows that reinforcement is necessary in pitch learning, and illustrates the length of time involved in 'forgetting' by a post-puberty subject.

The need to listen

Sarah Munroe of Australia found that many children with serious hearing losses often learnt to sing in tune more accurately than those with normal hearing because they were made aware at an early age of the need to listen.

TONAL RELATIONSHIPS IN PITCH LEARNING

Brehmer, Pflederer and Teplov* studied the order in which the degree of the scale related in tonal structure. There is general agreement with Franklin's hypothesis that certain points of the musical scale emerge as attentional focus points, the position of the remainder are perceived as fitting between the salient points.

In an experiment of mine, the attentional position in a musical sentence appeared to be of the same importance for pitch identification by non-A.P. subjects, as the actual pitch to be identified. No doubt the reason behind this is the better threshold of pitch discrimination for longer sounds, mentioned in the section labelled Duration. Notes in attentional positions need (for non-A.P. subjects) to be of sufficient duration to allow the melodic outline of the whole phrase to be pitched correctly.

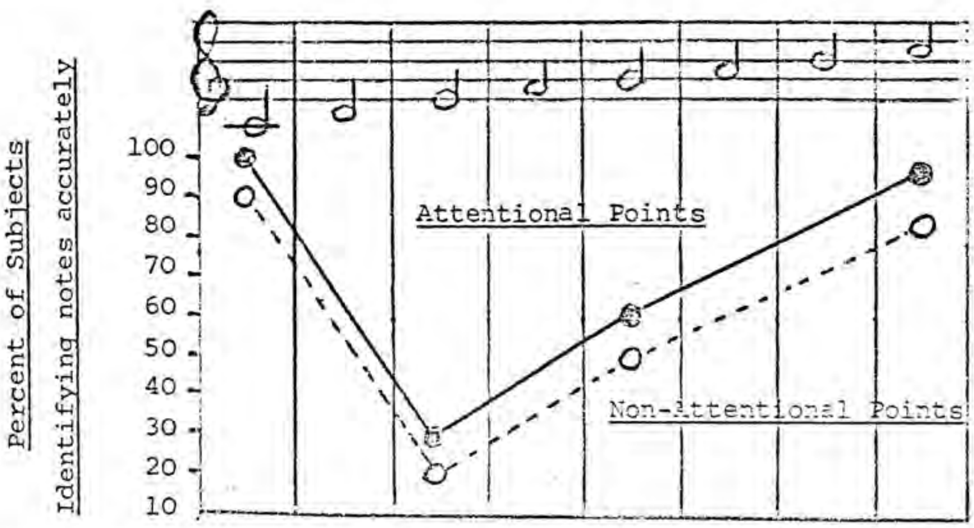
An improvement of 10% in pitch identification was noted when the note to be identified was in an attentional position. This was shown by the following experiment. 300 children in one Girls Public Day School Trust (G.P.D.S.T.) were given pitch training for two periods of 40 minutes per week, based on the training programme

*(Brehmer, 1925; Pflederer, 1974; Teplov, 1966.)

previously mentioned, from September until June of the following year. In July they were given short melodic dictation tests spread over four forty-minute periods to avoid fatigue. These tests were designed to test:

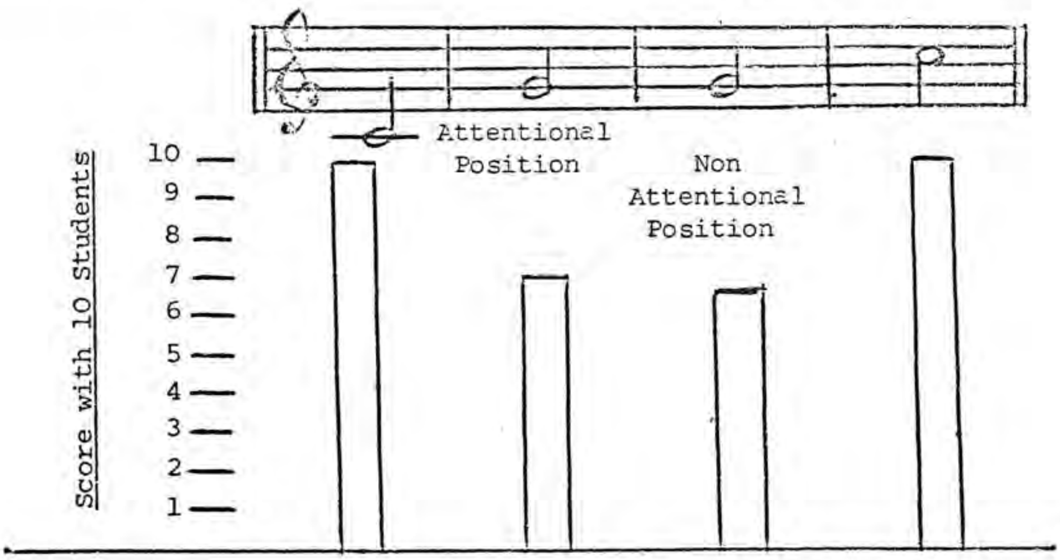
(a) The ability to identify individual notes without establishing a tonal centre. Between each note which had to be identified immediately, a cluster of four adjacent notes was played to destroy any tonality. These tests showed that Middle C was identified accurately by the majority, C was identified by nearly as many, G by approximately 50%, but thereafter there were only small groups identifying the various notes.

(b) The recognition of each degree of the scale in a musical phrase was then tested by a series of short phrases - each degree of the scale appearing in both attentional and non-attentional positions. These tests showed the general pattern of relative pitch learning described in the diagram below. An interesting point was noticed when the learning of each degree of the scale appeared to have an overall difference of 10% between the attentional and non-attentional positions.

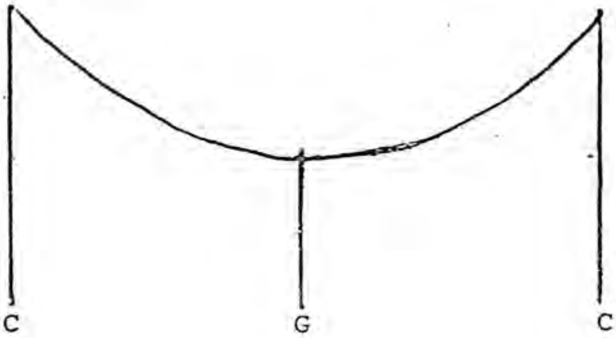


Attentional positions are created by notes of longer duration at phrase endings.

The identification of the remaining notes appeared to depend on the accuracy of the recognition of these four, i.e. C,E,G,C, - the learning appeared to spread to adjacent notes from these four. This test was repeated with 18-year old teaching students who received training twice weekly. A similar pattern was shown but with the slight variation that in this case it was noticed that the two C's were identified by all, regardless of position, but with G there was still the difference according to position.



The test was then repeated with groups of ten pre-school children, aged 3, 4 and 5 years old. They appeared to identify notes as single events unrelated to phrase position, but the pattern with these children was otherwise similar, i.e.



Peter du Preez, Department of Psychology, University of Cape Town, in his paper, 'Tone Groups, Information and Language Acquisition', states that the tone group, which is a unit of information closely tied to behaviour, is more easily applied to the study of the development of language in a child from the one-word tone group to the two-word tone group. He shows that the child:

(a) imitates the adult's tonic;

(b) has his attention directed by the adult's tonic;

(c) increases the length of his utterance by adding the next salient word to the tonic.

The differentiated tone group is necessary because tacting and manding increase more rapidly with age than does private language addressed to the child's own behaviour. He concludes that differentiation of the tone group can account for the development of grammar, and not the other way round. In my opinion a similar position exists in the development of relative pitch.

Thackray in his paper for the International Seminar on Research in Music Education, New Zealand 1974, summarised that:

(a) Most children develop a feeling for tonality naturally, without any special help or encouragement, though the age at which this becomes evident may vary considerably between three and under eight, or even older. However, by the age of six or seven in most children it is fairly well established.

(b) Feelings for tonality are clearly the result of children's experience of tonal music. If children were exposed to no tonal music, it was argued that no feelings for tonality would develop.

(c) We have much evidence to show that many four year old children improvise in a clearly defined tonality.

The work of Peter du Preez of Cape Town, G. Taylor of Hertfordshire (formerly of Cape Town), and Leontiv of Moscow, all show however, that the development of language itself assists in the child's feeling for tonality, but a language involving the pitched entoning of vowels would develop the learning of individual pitched sounds (A.P.) more than tonality since the direct relationship of pitch/meaning would be conditioned during the most optimum years for pitch learning.

Experiments with electronically generated spectral components, showing that the attachment of a single pitch to complex sounds is greatly facilitated by, or even sometimes requires, the presentation of the test tones in the form of a 'meaningful' melody (Houtsman and Goldstein, 1971). This stresses the importance of meaningful melody, which is further stressed by Roederer when he points out that individual electronically synthesized complex tones taken out of musical context may often lead to ambiguous or multiple pitch sensations.

Conservation

Marilyn Pflederer-Zimmerman, in her paper, 'Conservation in Musical Experience', describing an experiment using 679 junior school children found that:

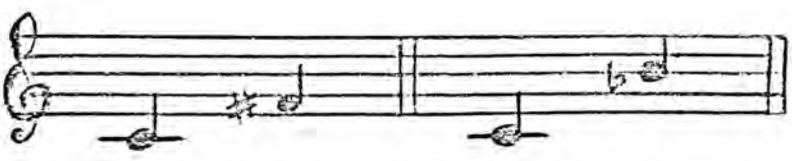
(a) Improvement in conservation of tonal patterns preceded improvement in conservation of rhythmic patterns.

(b) Training to enhance conservation was most marked at the ages of five to seven years.

Pflederer-Zimmerman also discusses the possible effects of centration on auditory perception through dominance of such factors as timbre. 'Tone colour of a trumpet may capture the focal point of childrens' perception, so that other information is excluded'. I liken this to the position during the early months when acuity of hearing for individual frequencies dominates the child's attention, and therefore learning. The strength of this domination in some cases is so strong, that I have found that some aphasic children give the impression that one of the reasons for their lack of speech has been a failure to move from total pre-occupation with individual sounds to the relating of more than one sound together.

Tonality Factors affecting Pitch Learning

Too early an Introduction of Chromatic Intervals and the Minor Mode. The introduction of Chromatic Intervals and the Minor Mode was experimented with at varying periods with the experimental group during the Training Programme, and it was found that too early an introduction impeded the pitch learning and introduced uncertainty. As a result of trial and error, it was found that quicker and more accurate learning took place if, first the diatonic scale was firmly established, which had usually happened by the ninth month - then two accidentals were introduced, i.e. the sharpened 4th and the flattened 7th and the two introduced into the daily drilling as intervals. Scalewise work was less effective.



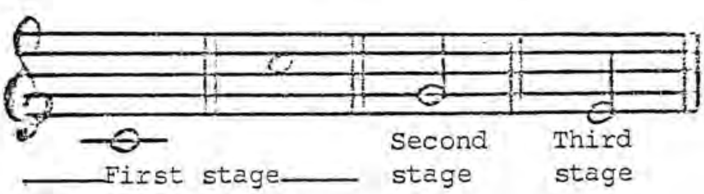
It appeared to be necessary to use the diatonic scale as the stepping stones for chromatic work. Experiments using the pentatonic scale seemed to be unnecessarily restrictive and as

Paul Michel says, 'to speak of a pentatonic stage of development would amount to under estimation of the active dialogue of the child with our musical system'. To check this statement, I carried out an exploratory investigation in a G.P.D.S.T. school for one academic year. The first years (aged 11+) were in two parallel forms, quite unselected as far as musical ability was concerned. Both groups of the thirty children received two training sessions weekly, and were of the same I.Q. range with similar sociological backgrounds. Group A were trained according to the training programme using the diatonic scale, but group B followed an adaptation of the programme using the pentatonic scale. The results of the tests at the end of the academic year showed the Pentatonic Group to be considerably below the standard achieved by the Diatonic Group in three respects:

(a) They confused the top doh with the sub-mediant

(b) There was a lack of the spread of learning of pitch to adjacent notes as noticed with the diatonic group. The learning of pitch achieved was similar in nature to the younger childs' learning for individual notes, but was less efficient, no doubt because of the age factor.

(c) There was noticeably less self-confidence in their own ability to sight sing among the Pentatonic Group. This was possibly because these children were past the optimum age for absolute pitch learning and therefore needed a tonal centre. This was confirmed by some general observations noted during the Training Programme developed over a period of ten years with a hundred children. Again as a result of trial and error it was found that the best starting point for pitch training was middle C. In 3 000 children tested I found only three variations. The pattern of progress which developed was as follows:



At this stage D, F and A followed, but appeared to be learnt as a step from or towards one of the four previous notes.

Practice took place until these were added to the repertoire. When this had been achieved, progress continued, but it was found that the 7th was more easily learnt by the interval.

It was described by the children as 'standing out like a sore thumb'.

Pitch learning at this stage meant the ability to listen to the given note, and then play the correct note on their pitched instrument, singing it in tune to the correct name.

Care was taken to avoid the impression of testing for memory of pitch, as it had been found that the too early testing that most so-called aural training in schools seemed to consist of, caused lack of confidence by drawing attention to the intangibility of sound before learning took place. Once the learning of the diatonic intervals was secure, and this was usually the case by the end of a year, it was safe to progress to the introduction of the two accidentals mentioned and the idea of the moveable 'doh'.

When this is established one can proceed to modulating and to the introduction of the Minor Mode. This must however be gradual as there is much evidence to suggest that work in the minor mode is related to uncertainty.

The Minor Mode and Apparent Lack of Definition

Three simple examples illustrate this, although controlled experiments were not possible.

(a) A group of twenty-two children were told to listen to two pieces of music on different afternoons; one was in a major mode and the other in a minor. They were then asked to draw or paint anything they liked which they felt fitted in with the music. Generally the major music brought out brightly coloured, clearly defined paintings, while the minor music produced 'wishy-washy', ephemeral paintings.

(b) In a school for emotionally disturbed children, the use of the minor keys had to be discontinued with the younger children, because of the uncertainty and emotional disturbance that it regularly created.

(c) A recording of a series of music therapy sessions with a patient in a Psychiatric Hospital illustrated the state of security of the patient. While he progressed towards being discharged his improvising showed his moving away from the minor mode to the major; eventually he was discharged. Later he returned to the hospital, having regressed, and his improvisation was back in the minor mode.

SUMMARY OF SECTION II

Pitch learning requires the establishment of a feedback system during the optimum years.

Three-year old children can discriminate between 𝅗𝅥 and 𝅘𝅥 but are only beginning to discriminate between figure and ground. Cut out notes, felt notes or magnetic notes, for placing on the stave should be used, rather than drawing notes on the stave by hand.

Relative Pitch learning requires a visual cue for maximum efficiency in learning. Traditional notation appears to be an adequate visual cue. It is important during early childhood to first introduce pitch without the assistance of a visual cue allowing maximum attention to be directed to the sound. A secondary cue however will be needed for meaning and identification purposes; initially training periods should start with pitch learning games without secondary cues, progressing to the inclusion of secondary cues, preferably visual, at a later stage. The provision of a visual cue is sometimes called 'aided hearing'.

Absolute Pitch learning appears to be greater when the visual fixation corresponds simultaneously with the presentation of the auditory stimulus sufficiently loudly, sufficiently often, and without variation during the first six years of life; variation can prevent learning. The fixed 'doh' method is therefore likely to be most useful at this stage. If the moveable 'doh' is introduced too early it could possibly interfere with pitch learning at this age of acuity for absolute pitched sounds, which is without the reversibility of mental action required for Relative Pitch learning.

Relative Pitch learning requires reversibility of mental action and the maturity of eye movement necessary for the development of visual span. It would appear therefore that Relative Pitch work and the moveable 'doh' method could usefully be approached by approximately six years of age. By this age the A.P. acuity of the child has begun to drop, making decentring possible.

The learning of notation is essential since it is an act of definition. Pitch learning will be limited to that which can be separately defined. It is therefore important to have an adequate notation.

Complex rhythmical work can impair pitch learning during the optimum years, there should therefore be separate pitch and rhythmic training.

First learning of pitch belongs to the pre-puberty years, whereas there is no decline in rhythmical development until about eighteen years of age. Pitch learning should therefore receive priority during the pre-puberty years.

Training in rhythmical work and the recognition of rhythmical patterns assists in the development of eye movement.

Pitch learning is an interactionary process - a response from the subject must be evoked before learning can take place.

The use of colour to assist pitch learning is undesirable during the years of the greatest plasticity of the brain.

Tactual, Spatial, Motor and Kinaesthetic cues assist and reinforce relative pitch learning and the more senses involved in any one piece of learning the quicker and more efficient the learning.

The nearer the subject is to puberty the greater the need for the maximum use of supporting cues.

Time is an important factor in pitch learning. A period of a year appears to be significant.

Twenty minutes daily training, first thing in the morning, five days a week, appears to produce the best results.

Although first learning of pitch takes place during the pre-puberty years, reinforcement at the post-puberty stage is necessary to maintain learning.

There is greater pitch identification for notes in attentional positions in musical phrases.

Middle C, C', G and E appear to be learnt by the majority of children first and in that order. Further learning appears to spread to adjacent notes from these four. Once the Absolute Pitch learning period is past, a premature introduction of Chromatic Intervals and the Minor Mode hinders Relative Pitch learning, produces uncertainty and a lack of confidence. These should be delayed until the diatonic scale is firmly established, i.e. usually after one year of training.

Testing, instead of teaching, should be avoided in Aural Training until confidence has been gained by the subjects in their own pitch memory, as an emphasis on testing draws attention to the ephemeral nature of sound. During the years of the greatest plasticity of the brain it is important to first store information. Testing pitch memory before its acquisition is non-sensical.

The softest level at which training can be carried out demands attention in order to be heard and therefore encourages critical listening. Loud sounds make no such demand. Training to listen must surely result in the most accurate intonation and learning, subject to the relationship between complexity of tones and dynamics.

Ambiguous pitch sensations can arise if electronically synthesized complex tones are presented out of musical context.

SECTION III

THE AGE FACTOR

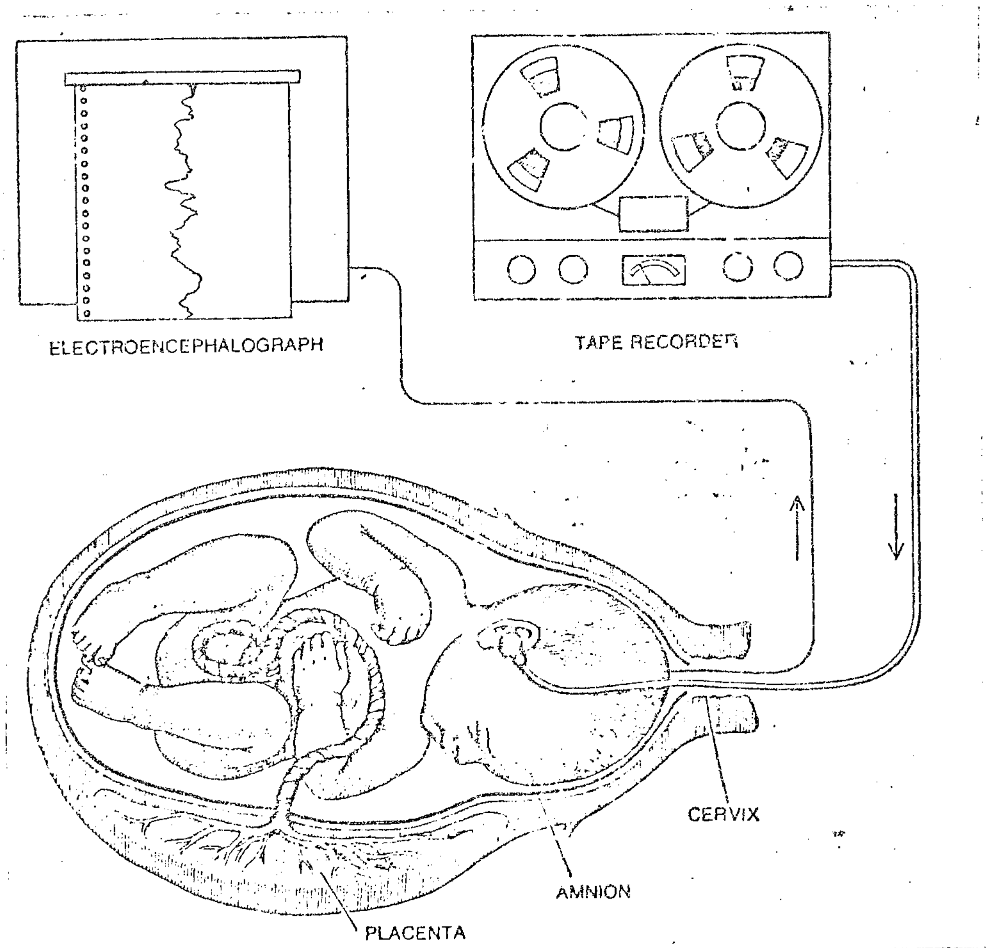
Pregnancy

Surgery has provided proof that the hearing mechanism is of complete size by the sixth month of pregnancy. There is no neural connection between mother and foetus to make the transmission of learning possible says Sergeant, and Corner (1944) supports this by pointing out that not a single nerve fibre crosses the barrier yet as Murphy* reports, the foetal heart rate increases after Pure Tone Stimulation through the maternal wall. Why must there be a neural connection? Is it not possible for the sound to reach the auditory mechanism of the foetus, which surgery has shown to be fully developed by the sixth month of pregnancy? After all sound can be conducted by fluid and human tissue although this is not a particularly good conductor. There would of course be some masking of the sounds by the mother's heart beat and gastric noises.

The California Research Project has shown that the foetus responds to sound from the sixth month. An apparatus for monitoring foetal responses during labour is shown, in schematic form, on the following page. (Copied from Scientific American Magazine. The work has been pioneered by Edward H.G. Hon of the University of Southern California.)

(*Murphy, K.P., 1962.)

Apparatus for Monitoring Foetal Responses during Labour



Above, shown in schematic form, is the apparatus for monitoring foetal responses during labour. A flexible stainless steel electrode is introduced into the uterine cavity through the dilated cervix after labour has begun. The electrode is attached to the scalp and picks up changes in brain-wave activity. A miniature earphone is also introduced through the cervix and positioned near the foetal ear. In a study with six volunteer pregnant women one foetus had a consistent evoked response to sound delivered through the earphone.

The sound stimuli delivered to the foetus was in bursts of 10 000 Hz. It is worth noting that the mother of the responding foe the only one who had not been given a drug to stimulate ute contractions.

This has important implications for the study of pitch learning and language acquisition, since it could mean that the child is born with three months experience of sound. It is therefore possible that much that has been described as innate ability, could be explained by this three months experience. To estimate the type of sound stimulus received by the child is consequently of importance. A study of the conduction of sound in fluid together with the effect of human tissue is therefore necessary, in attempting to establish the nature of sound arriving at the foetus. That sound localisation is possible via the human skin, see the work of G. von Békésy (1955).

Additionally one must establish whether the foetal middle ear is filled with fluid or air. If filled with air then according to Dr. Brian Ray of the Marine Unit Technology Underwater Centre, Fort Bovisand, Devonshire, England, 'the hearing threshold is typically between 50 dB and 70 dB ref. 0.0002 dynes/sq.cm.' The sensitivity corresponding approximately to the bone conduction threshold in air. According to Anson and Donaldson however, pneumatization of the tympanum is not nearing completion until between the eighth and ninth month of foetal life, which means, as Dr. T. Jarvis of Groote Schuur Hospital explains, that both spaces of the middle ear before pneumatization are almost certainly full of amniotic fluid which would make hearing in the foetus entirely fluid borne.

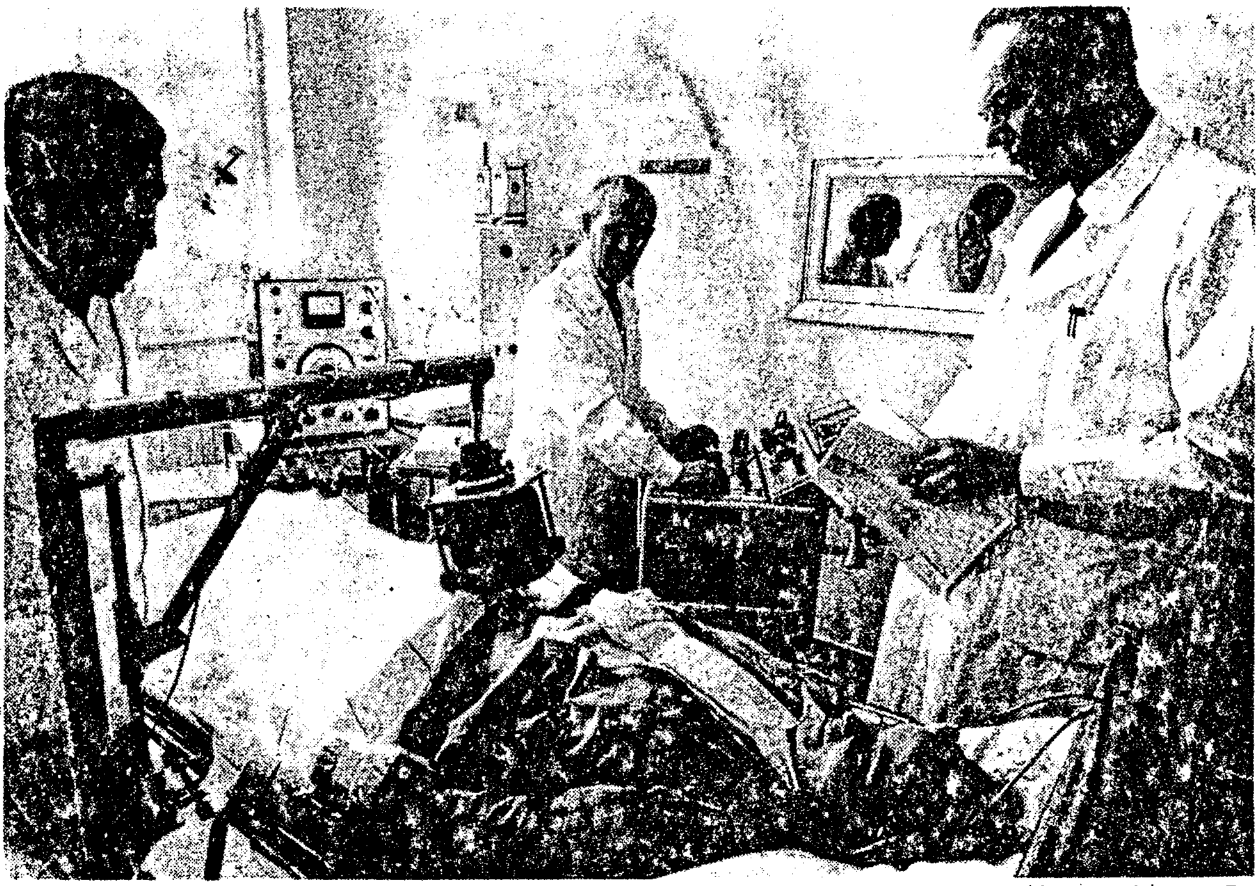
According to Brandt and Follien the underwater threshold SPL is constant as a function of test frequency up to 4 000 Hz with a mea[illegible] about 68 dB. The underwater speech reception threshold is ab[illegible] [illegible]3-15 dB above the pure tone threshold averaged over frequency ra[illegible] 125 - 4 000 Hz; about the same as that obtained in air for the same subjects. Hollien goes on to say that it would therefore appear that the increased SPL required for the underwater threshold is due to a conductive impairment produced by the combination of:

(a) the occlusion of the external auditory meatus by the water medium;

(b) the mismatch of impedance between the air in the middle ear and the water medium.

(c) The mass loading of the eardrum and middle ear mechanism.

The high scores (96% correct) obtained from diver/listeners submerged in water in the tests carried out by Hollien, suggests that speech reception and discrimination are similar in water and air.



An unborn child is checked for possible hearing defects. Attending the mother (from left) are: Dr Erik Wedenberg, physician audiologist; Mr Bentil Johansson, audiologist engineer; and Dr Bjorn Westin, obstetrician.

(Reproduced from Sunday Times)

In the above photograph scientists are trying to gauge the foetus's hearing capabilities. The mother has a buzzer device cupped over her abdomen below her navel, about four inches from the ear of the foetus. The mother wears headphones and a masking tone is used to prevent her hearing the tone bursts from the buzzer. When the mother is relaxed the buzzer emits a loud tone burst. The sound startles the foetus causing its muscles to tighten and quickening its heartbeat. These changes are relayed to a chart-writer. The results of these tests also supports the opinion that the child is born with three months experience of sounds.

Bengtson (1971) also states that, 'Memory storage of acoustical experience may start at the late intrauterine stage with the foetus perceiving the mother's heartbeat, voice and gastric sounds as well as external sounds filtered through the amniotic fluid' (Stockholm Karolinska Institute, Audiology Department.) The research into the use of the recorded sounds of a mother's heartbeat to pacify new-born babies being carried out by the London Hospital, Whitechapel,* would further support these findings. A consideration of the nature of the sound experience apparently possible from the sixth month of foetal life may be another explanation of the various theories of aesthetic response (Leonard Meyer), and of perceptual report (Bruner, Postman) as reported by Carlsen (1976). The possible transfer of learning through chemical processes, as demonstrated in experiments on rats, must also be considered. (Fjerdingsgad, 1971).

The first eight months of life

In order to explore the babies' response to, and learning of pitched sounds during the first eight months of life, I first recorded baby sounds from Nurseries, Hospitals and private homes; these were then edited according to age in order to establish the response evoked. Mothers and babies visited me once a week for an afternoon session of playing with sounds, to explore those sounds most likely to evoke a vocalising response, and to observe any other reactions to the sounds. These were carefully recorded.

Tape recorded Pitched samples using the Glockenspiel with an Auditory Trainer amplifying the sample at varying intensity levels were presented, via two loudspeakers, placed at three feet from the child and on the level of the child's ears. The child's response was observed and recorded, as the frequency range and intensity level was varied. The responses noted were momentary freezing, flickering

(*E.M.I. released the recording used on an LP entitled "Sleep Gently in the Womb" on EMI-EMA 773.)

of the eyes, turning of the head, and occasional 'goos' and smiles. The babies were obviously hearing the range of pitched sounds presented.

This being the case fluid-borne hearing of the fully developed adult would only need compensation for the threshold changes produced by the medium (fluid) itself, i.e. the hearing is essentially via bone conduction with a substantial 'conductive' loss, and threshold relatively flat at approximately 70 dB.

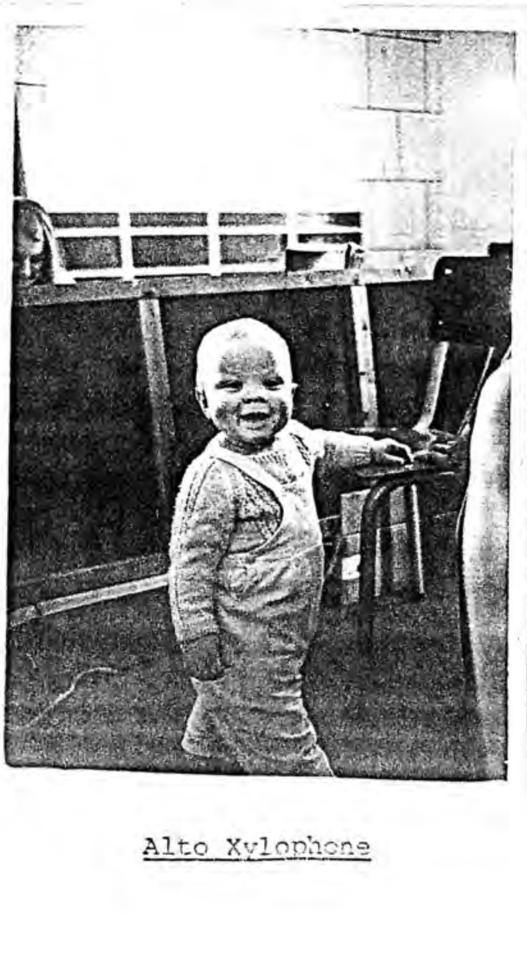
Once the threshold of hearing is reached for the underwater listener, the relationships between speech reception and discrimination are similar to those prevailing in air. However, in the case of the foetus prior to pneumatisation, the middle ear is apparently full of fluid. If this is the case, would the 'mismatching of impedance' still occur?

In an experiment designed to test the pitch discrimination ability of the baby during the first year of life, I prepared a collection of pitched percussion instruments behind screens so arranged as to form a circle. The mother sat on a chair in the middle of the circle and her child sat on the floor at the mother's feet. Students who were behind the screens then proceeded to 'bombard' the child with individual notes of varying pitch and softly played nursery rhymes, whilst I noticed the baby's response, and watched the Sound Level Indicator (open University Model, CS 15C). Although recording the sound levels at which the varying responses were evoked, I was primarily concerned with any changing responses according to the pitch of the stimulus. The following photographs attempt to record an eight month old child's variation of responses according to pitch, showing that pitch discrimination is possible.

Non-Pitched Drum

Alto Metallaphone

Soprano Xylophone



Alto Xylophone

Soprano Glockenspiel

Bass Xylophone

N.B. Notice the similar expressions on the faces of the baby and the student yet neither is aware of the other!

The mothers were taught to play simple nursery rhymes at the piano and to sing them to the child holding the child on their lap. Responses were noted daily. Soon it was noticed that the child turned correctly to the part of the piano being used by the mother.

Contented babbling and chuckles were the usual responses but some mothers recorded that their baby soon began to look towards the correct part of the piano when they played notes of varying pitch. This appears to begin at approximately two months. Most mothers recorded that their babies were happy with softly played notes, but disliked loudly played notes - even to the point of screaming.

I continued with the exploration of the growing child's response to sound, by circulating a questionnaire* among mothers of young children, asking for their observations on the sources of sounds which were noticed to attract the attention of their baby in any way. When these questionnaires were analysed, I found that during the first eight or nine months of a child's life, a child was concerned with individually pitched sounds and his response to them appeared to be related to importance and pleasure of basic needs, i.e. feeding spoon, cup, toys, etc.

Tape recorded records of the babies' attempts and progress in vocalising (when analysed) produced the following observations. Attempts at vocalising are initially the result of interaction between child and mother (or mother substitute), and appeared to be entirely unaffected by external stimuli, as without the social support of this relationship the babbling gradually died away regardless of available sources of sound stimulus. The mere presence of the mother however was not sufficient, interaction was an essential prerequisite for vocalising to continue beyond the eighth month. Vocalisation has been shown by others to be part of the process of the learning of sounds. This pattern of behaviour, i.e. from babbling to silence was found in two groups:

(*Copy in Appendix, p.302.)

(a) Those born deaf.

(b) Those deprived of mother/mother substitute and child interaction during the optimum years.

Stimulation to babble is therefore seen as an essential to establish the necessary auditory feedback in order to continue and advance in both vocalisation and the relating of sounds. Without vocalisation there appeared to be no progress towards the relating of sounds one to the other and the forming of pitch phrases. The baby remained at the stage of direct associations with individual sounds. It was found that each sound was practiced a great deal before proceeding to a new sound, and that stimulation was necessary to start off the sessions. The sources of stimulation noticed to start off such a babbling session were:

(a) Mother making physical contact by lifting, patting, tickling the child while talking to it (the meaning of the conversation was clearly unimportant and could be absolute gibberish providing the tone was pleasant and physical contact made). Tappolet (1907) was able to switch from French to German while retaining the same intonation without affecting the young child's response.

(b) Animal or bird sounds or family pet entering the room. Seeing the family pet was sufficient to stimulate sound making - the copying of the sounds made by the animal on earlier occasions showed a memory for the pitch of sounds. Bernard Rands and Christoper Small also show how visual patterns act as stimuli to sound making. (Rands, B., 1973.)

(c) Sounds of approach of food.

(d) Singing to the child, playing with a rattle or other toy.

(e) Babies, in the presence of others of similar age, copied each others' vocalising attempts, one appearing to stimulate the other. The exactness of the pitch copied is very noticeable.

(f) Tape recorded samples of the baby's babbling when played to the same baby on another occasion, stimulated further babbling.

(g) Noises from the child's immediate environment, providing they occur sufficiently often without the unpleasant association that could cause rejection with the consequent failure to learn, stimulates the child to babble. Some of the sounds that are apparently being remembered from approximately two months of age have been observed to be:

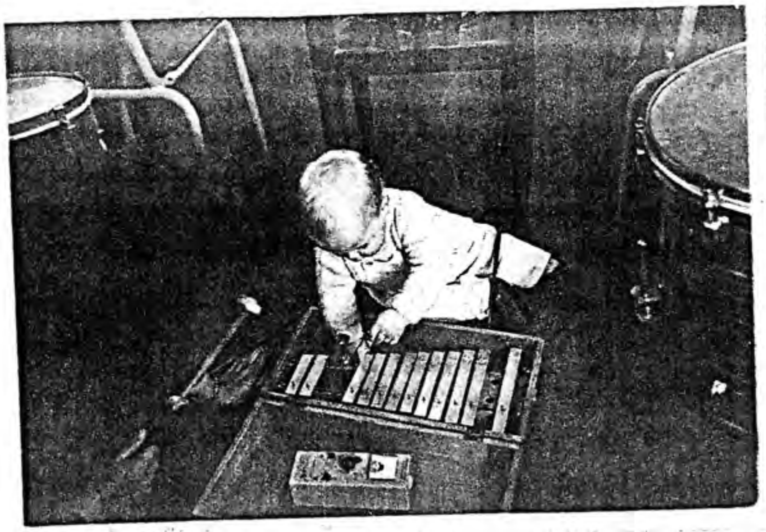
(1) Voice of member of family;
(2) Spoon against cup;
(3) Tap running;
(4) Rattle, toy;
(5) Door slamming;
(6) Footsteps;
(7) Door bell.

This stage of direct association between sound and experience is the beginning of the auditory memory required for all language and music skills. If the environment is without sound or variety of sounds then there can be no experiencing of the associations necessary for the acquisition of auditory memory. It must also be realised that this deficiency fails to provide the prerequisite experience to enable Pitch Discrimination to develop. Consequently sounds will appear mere noise to the child, lack individual interest and therefore quickly be rejected and not learnt. The failure thus becomes a central problem as without the learning of meaning, perception cannot develop.

The introduction of the child to sound making toys, and then encouraging him to play with them was yet another source of stimulation to babble. The child also began to copy the sounds he found interesting. Interest was seen to be a very important factor. Inability to experience differences in pitched sounds resulted in lack of interest in all sound, which led to lack of learning.

Pitched

Non-Pitched



Trying for himself

Removes the Tone-Bar
previously played

Trying to imitate my playing
on the drum

Concentration as he tries to copy

Exploring for himself

The child imitated my playing on the drum but removed the tone bars of the Glockenspiel that I had struck as if expecting this action to result in the sound being reproduced.

Concentration as he tries to copy

Exploring for himself

The child imitated my playing on the drum but removed the tone bars of the Glockenspiel that I had struck as if expecting this action to result in the sound being reproduced.

The problem was quickly shown to be that of retaining the child's interest for sufficient length of time to permit learning to take place, since once the sound became familiar the child lost interest in it. This is a true indication that the survival type hearing with which they are born had not yet become listening. While the interest was retained the baby responded to very soft sounds, but once the interest was lost quite loud sounds of the same pitch were totally ignored. A smile often appeared after a high pitch sound when a lower one of the same intensity level had been ignored.

A second stage appeared to be reached at about six months, when the child started to interrupt itself every now and again by exploring its whole vocal range even to the point of screeching. It seemed to be entirely exploratory as the child made no attempt to isolate sounds within the exploration. The amount of practice that each sound received appeared to affect the progress of the child towards the learning of the sound. All babbling was recorded and studied. It is important for the 'purist' musician to notice just how many of the sources of stimulation in pitch learning of the young child were non-sound source. This may help them to understand the need for some of the games used by such people as Kodaly, Suzuki, etc., in order to attract the young child's attention sufficiently long enough to permit learning to take place.

Between the eighth and tenth months the tape recorded babbling showed a gradual departure from the monosyllabic pitched sounds. This appeared after much practice of the individual sounds followed by vocal exploration. Two syllable sounds started to appear and the following changes were noted:

(a) When copying each other for the first time there now appeared the occasional lack of exactness of pitch on the second sound of the pair.

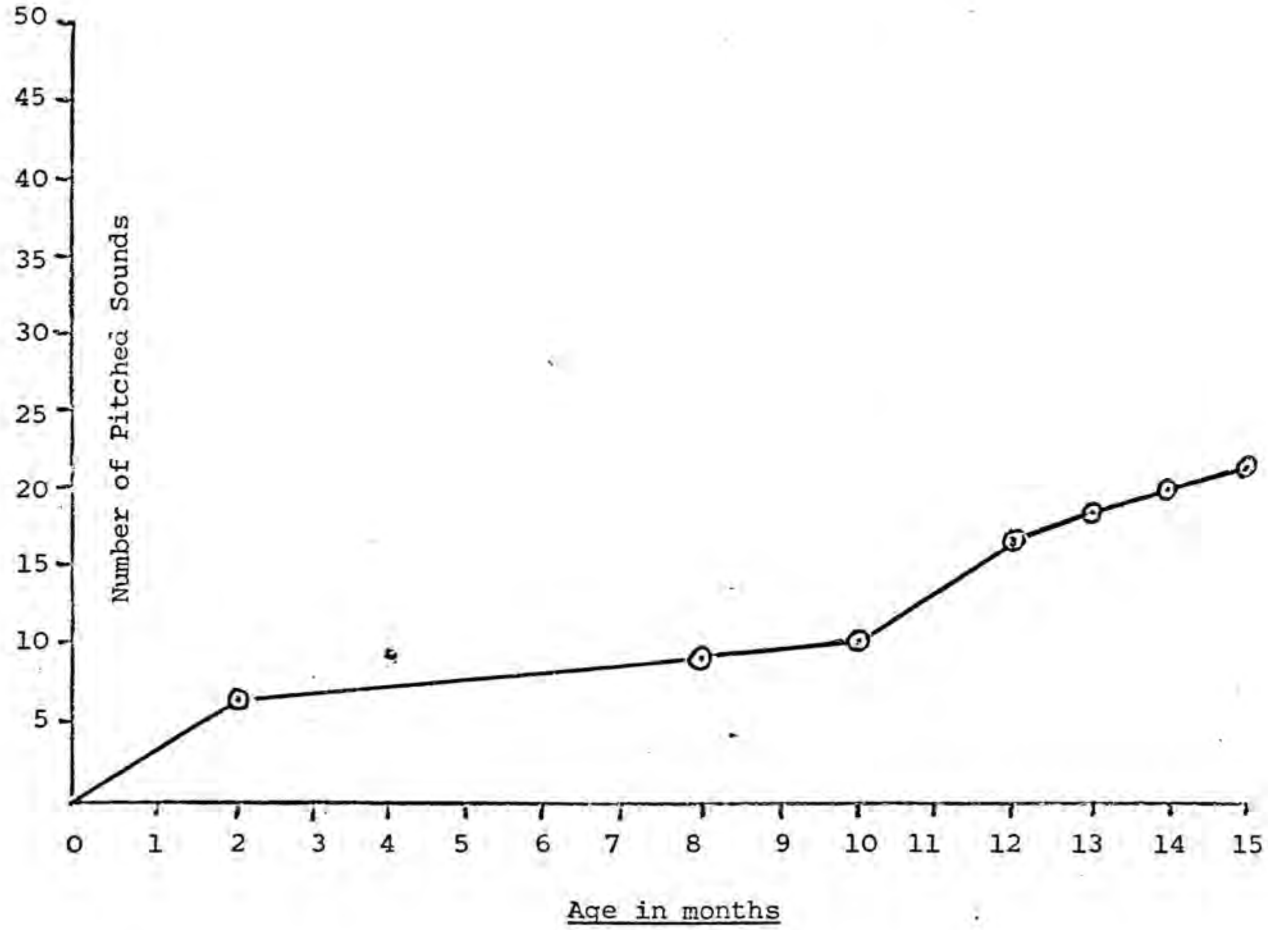
(b) There was a greater need for meaning to be attached to the sound.

(c) There was no longer the continuous spontaneous copying of each other's sounds.

(d) There was no longer the same degree of fascination for single sounds, the children appearing to be more concerned with the relating of sounds to meaning and the vocal experimenting of more than one sound together. Pitched sounds on the Xylophone attracted the childrens' attention for a short while only, they soon lost interest.

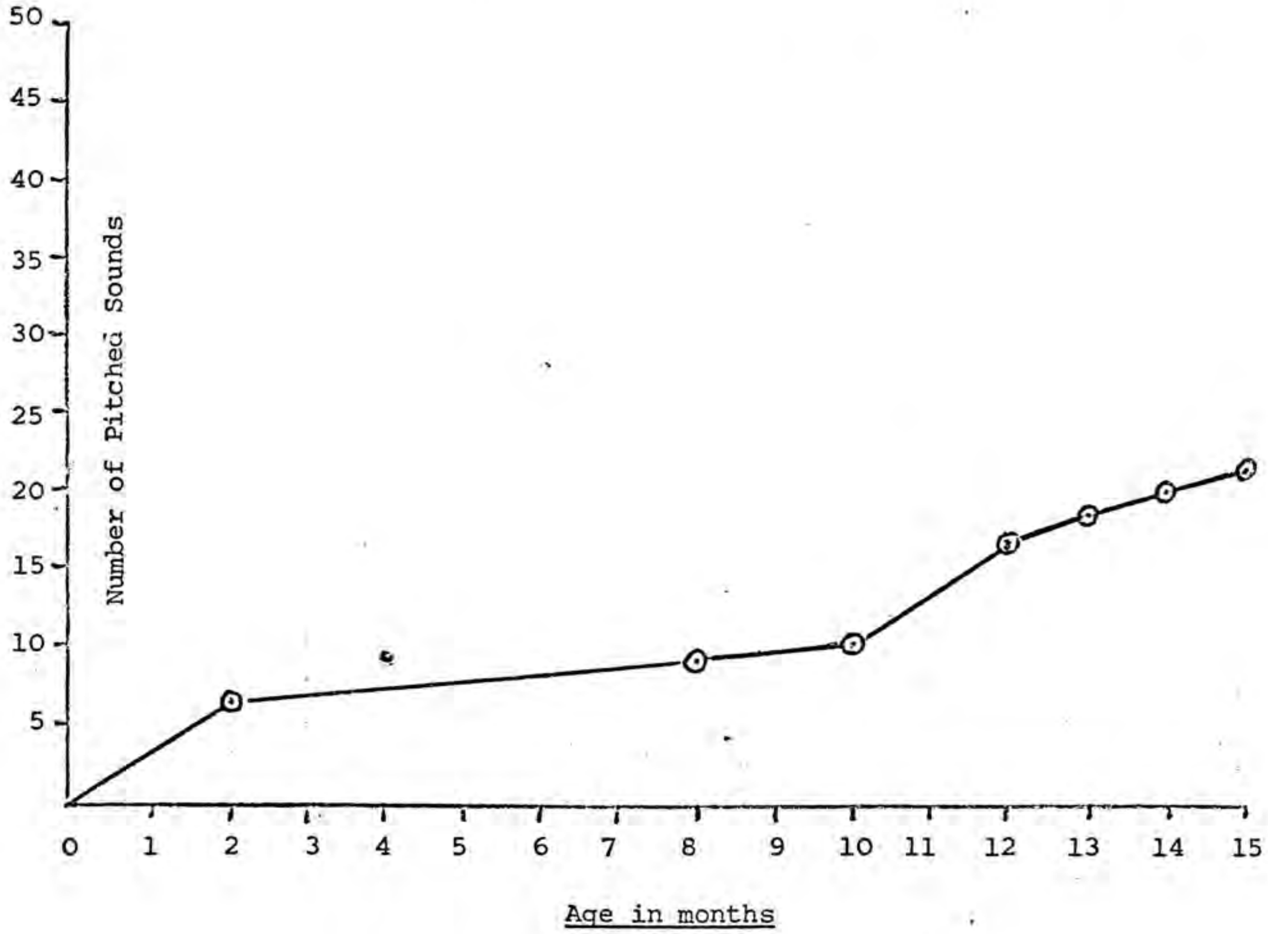
From the tape recordings I then charted the number of pitched sounds that the babies were learning. Twenty-two babies were used, their vocalising tapes, edited and analysed. This information was further checked with the written records kept by four of the mothers.

Pitch sounds vocalised by babies.



For the purpose of the graph the score was counted when the tape recordings showed that sounds were vocalised at exactly the same pitch as earlier vocalising, the vocalising being stimulated by tape recordings of other children. The intention had been to show the Absolute Pitch learning of the child, but it was noticed that even without the stimulating tape recordings of the child's earlier vocalising attempts, the sounds learnt were repeated at exactly the same pitch as the earlier vocalising. I began therefore to form the opinion that the child's survival hearing with

Pitch sounds vocalised by babies.



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Experiments with young babies during the first three years of life involving the tape recording of their responses to pitched sounds and phrases, followed by the analysing of the recordings, showed that it is the ability to learn Absolute Pitch through the acuity of hearing for sounds of fixed pitch with which the child is born, and not the presence of Absolute Pitch. The lack of reversibility of mental action of the newly born child ensures total preoccupation with individual sounds and their variation of pitch, intensity and duration (all a function of frequency). Variation of pitch however must equate with variation of experience.

Prior to the development of vocabulary, attention is directed solely to those aspects of sound as they are the only source of information and meaning. Consequently it is the pitch of the sound which will first be learnt, subject to sufficient meaningful experience at this age.

Hanus Papusek of the Institute of Care of Mother and Child, Prague 4, is of the opinion that the child is born with Absolute Pitch from which it gradually moves if there is insufficient experience to ensure fixation. He attempts to show this by measuring the child's reflex response to pitch. His experiments at least give information as to the child's ability to hear sounds of varied pitch, one of the necessary preliminaries to pitch discrimination.

Dr. Die G.S. Stephens, Audiology Department of the Institute of Sound and Vibration Research, Southampton University, also supports the view that the nature of the child's hearing at birth is of Absolute Pitch and claims that they are educated away from this.

Direct relationship with the individual sounds is essential for learning. This is shown by the way in which the reflex (startle) response of the newly born child quickly changes according to association with the sound. A new sound will bring the usual startle response but as the sound becomes familiar, so the reaction varies according to its association, i.e. sounds of food on its way will bring happy gurglings, sounds with unpleasant associations will bring tears or fear, sounds without direct meaningful association to the child will bring boredom and loss of any response similar to that of a deaf child. In trying to attract the children's attention to the pitched sounds I continually found that once the pitched sound became familiar, if it had no other meaning associated with it, they lost interest. One way to interest the child was for the mother to be involved in some pitch making activity such as singing or playing. When rewarding each correct response with a sweet each child's interest was again roused and continued for longer than the initial response, showing that it was not its potential ability that had dropped, but its desire to respond. It is this latter lack of response that in my opinion causes the difficulty in the learning of Absolute Pitch. How does one bring meaning into pitch learning at the stage when optimum conditions prevail for Absolute

Pitch learning, when by the same token the child cannot relate sounds one to another in order to form meaningful wholes? The answer would appear to be by direct, pleasurable and meaningful relationships to each sound.

In this research it can be noticed that Absolute Pitch as distinct from Relative Pitch has only been learnt, when such direct associations have taken place during this optimum period, which for the greatest degree of learning appears to be approximately the first three years.

As Dr. Elder points out, the babies' hearing appears to be similar to that of certain high grade animals, i.e. they both have the acuity of hearing for individual pitched sounds.* The use of vocabulary with both, can be varied without change of response providing pitch and tone remain the same. Properly structured sentences are ignored as meaningless by animal and baby, while both depend on the pitch and tone of monosyllabic 'sentences' for information. Pitch becomes, by experience, the means of discrimination between what could otherwise become meaningless sounds. That this is an important stage of learning, is shown by the number of normal children with language and learning disorders due to having been deprived of the opportunity of relating meaning to single, fixed pitch sounds. The responsibility for this lies with those parents who insisted on 'properly constructed sentences' at the stage when what was required was a one to one relationship. (In this respect the children of teachers, lecturers, etc. appear to be the most 'at risk'.)

Like many children exposed to several languages simultaneously during the first learning stage when sufficient practice, without variation, of the one to one relationship is so essential, many have failed to acquire <u>any</u> language adequately. A developed pitch memory is vital for language development.

It is perhaps worthy of note that while children given the opportunity, gradually extend the relationship of sounds to phrases and sentences and move away from the monosyllabic 'sentence', so their absolute pitch acuity fades. On the other hand, while the animal does not progress from an understanding of the monosyllabic stage and continues to rely solely on pitch and tone for information, it retains its acuity of hearing for absolute pitched sounds. This would appear to support Dr. Stephen's statement that the child is educated away from Absolute Pitch.

The child's hearing acuity for high pitched sounds (reflex hearing) is described by many as reaching its peak by the age of three years and beginning to decline by the age of six years. In my opinion the reflex hearing is at its most acute at birth and from then begins to decline. This opinion was formed as a result of games and experiments with young babies, where the babies' changing reactions to sounds of similar intensity were noted. Controlled experiments however were not found practicable. I suggest that this opinion is further supported by three observations:

(a) Noise damage appears to be caused by oxygen 'hissing' into incubators at approximately 65 dB S.P.L. when newly born babies are placed inside. The same damage apparently does not occur when an older baby receives similar treatment. Could this be that the hearing has become less sensitive?

(b) There appears to be no attempt by the baby to monitor its own vocal output through its hearing until about eight months.

Perhaps the hearing has not dropped sufficiently in pitch until this age to be within the child's vocal range and therefore of use for monitoring purposes.

(c) The greatest accuracy in the learning of Absolute Pitch appears to take place during the first three years of life, the stage of extreme hearing acuity for high pitched sounds, declining steadily until puberty.

Pitch learning is thus seen to be vitally important for speech and language development. Roederer describes pitch learning as a by-product of speech. I cannot help wondering if speech is not the by-product or extension of pitch learning.

<u>Investigation of the child's response to Pitched Sounds between the age of two and seven years, using the Orff tuned percussion instruments in weekly sessions of forty minutes with 97 Children</u>

(A) <u>Two and three-and-a-half year old age group</u> (<u>23 children</u>)

As a result of trial and error it was found that the Glockenspiels were too <u>small</u> for this group and the bass Xylophone did not <u>attract</u> the children in this group. The Sporano and Alto Xylophone appeared to be suitable and appealed to the children.

Each child was first given a xylophone with all the tone bars on it to make the complete diatonic scale. The child of this age was confused by so many tone bars and in spite of careful explanation and demonstration could not select any particular tone bar. All the tone bars of the xylophone were then removed with the exception of G and C. G was called the top note and C was named the bottom note with the xylophone held up to show the relative positions. I played the top note and then asked the children to play the top note on their instrument; this presented no difficulty. I then repeated this using the terminology high and low, again the children had no difficulty and played the correct note. I repeated this a third time using the terms 'soh' and 'doh', showing them which was which several times but the children could not identify the correct note.

The next experiment was getting the children to listen with their eyes closed while I played a note, and then when the children were told, they had to open their eyes and play whichever note they thought it was. They could all do this without hesitation; they could also name it as either the top or bottom or the high note or low note.

I then produced a Cardboard Ladder which the children correctly labelled as a ladder without prompting and described it as something they could climb up and down. I then showed a special ladder I had made for them with only two rungs on it like their xylophones. I also cut out a note from black cardboard. I held my xylophone alongside the latter and showed the children that when I placed my note on the bottom rung of the ladder I played the bottom tone bar, and then when it was placed on the top rung I played the top tone bar on the xylophone.

I found the following:

(i) The children had no difficulty in playing on the correct tone bar when I placed the cardboard note on the cardboard ladder providing the terms high, low, top and bottom were used, or I stuck the note on without any comment at all. They were confused however at any attempt to introduce either letter names or tonic solfa.

(ii) The cut-out note was only regarded as a pointer since they found it impossible to play one sound to one note, but they eventually stopped banging on the tone bar when I removed the note from the ladder. To the child the cardboard note meant banging on the appropriate tone bar on the xylophone all the time the note was stuck on the rung of the ladder; they clearly were not coping with notation.

(iii) Experiments with G and E or C and E instead of G and C were not at first successful. The children found it easier to discriminate between G and C. Games were then invented involving discrimination between the two notes G and C. When they appeared to lose interest I assumed that they were ready to move on to the smaller interval and I introduced E as the middle note; this was after five weeks. The middle note was introduced in the same way as the top and bottom notes, i.e. on the xylophone held alongside a three-rung ladder while I played on each tone bar labelling it Top, Middle and Bottom.

The same procedure was followed until once again the children appeared to lose interest; this happened after three weeks. Again I tried to introduce Tonic Solfa but the children could not cope. We then practised touching our feet for the bottom note, our middles for the middle note, our heads for the high note and stretching up with our hands for the new sound, i.e. A the sixth from C, but for three weeks the children could not cope with the new sound although they quickly lost interest in the other notes. In the fourth week they all:

(a) Suddenly absorbed the new note.

(b) Began to cope with the Tonic Solfa naming of notes.

(c) Were able to listen to the note being played and find it on their instruments and place the cardboard note on the correct rung of the ladder.

(d) Were able to sing doh, me, soh, lah as they played their instruments or placed their notes on the ladder. They could not cope with playing one sound to each note but continued the drum roll type beating of the tone bar.

(e) Rewards kept the child's interest for a longer period and produced a greater accuracy of response.

(f) I.Q. appeared to have no relationship to the child's ability to discriminate pitch when vocalising, but did affect the use of terminology in identifying pitch and the ability to match sounds on an instrument. (Terman and Merrill tests were used to assess the child's I.Q.)

(B) Four year old age group (26 children)

The same procedure was carried out with this group as with the younger group. It was found that the smaller Glockenspiels were possible with this group. The following points were noted:

(1) The terms Top, Bottom, High and Low were used to introduce the Tonic Solfa names which the children then learnt within the first three weeks.

(2) The same order of introduction of notes was needed with this group as with the younger group, but they did not need so long to master them and it was possible to introduce the sixth from C as 'lah' much more quickly.

(3) The children's response to pitched sounds was different in this group, they did not lose interest in a sound once it became familiar, but appeared to gain confidence in their ability to play

the correct note or sing it correctly to tonic solfa. They could all:

(a) Play the correct note on their instrument after listening to me play it on the piano. The notes identified by all accurately were C, E, G, A and C' after three months practice.

(b) Play the correct note after I placed a note on the ladder. A few were also able to sing it without instrumental support.

(c) Listen to the note played and place the note on the correct rung of the ladder.

(d) This group were able to play single notes to each note placed on the ladder although it appeared to be an effort.

(e) They were able to learn to discriminate between 𝅗𝅥 and the 𝅗𝅥 by playing single notes for 𝅗𝅥. and keep banging when I placed 𝅗𝅥 on the ladder.

(f) The children could read tunes playing them note by note correctly as I put them on the ladder but could not cope with reading phrases moving from left to right.

The nature of the child's hearing appears to move away from attention to the Absolute Pitch sound from about the thirtieth month, by three years approximately they begin to (a) relate sounds and build tunes; (b) relate sound to symbol.

(C) <u>The four plus to five year old plus group (16 children)</u>

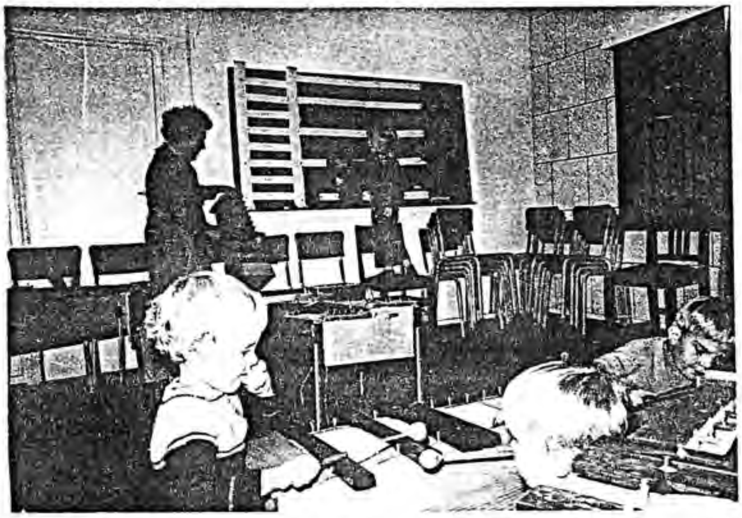
The work described in the earlier groups was coped with easily and the following additional points were noted:

(i) Melodies could now be read from left to right, sung to tonic solfa and correctly played on their instruments. When placing notes on the board to make tunes, they needed extra help to place the notes from left to right.

(ii) 𝅗𝅥 plus 𝅗𝅥 meant 𝅗𝅥 and not just two short and a long note.

(iii) The whole diatonic scale was now being used and sung.

The Stave was now introduced in the following manner. A cardboard ladder was pinned at one end of the blackboard and strips of card of the same width as the rungs of the ladder were pinned across the blackboard, e.g.:



Notes were stuck on the appropriate places and it was explained that sometimes the rung of the ladder was on a line and sometimes a space. The children had no difficulty in playing the correct notes in the correct order and in identifying the tune. They could also point to each note on the board and sing each note in tune as they touched it. The value of 𝅗𝅥 was demonstrated by attaching a piece of string on the back of the notes, i.e. 𝅗𝅥 𝅗𝅥 then tying them together and explaining how they meant the same as 𝅗𝅥

At this stage the children were able to:

(a) Find each note of the diatonic scale on their instrument when reading it from the ladder or stave.

(b) Listen to any note being played and then correctly identify it by playing it on their instrument.

(c) Point to the notes on the Stave and sing them to tonic solfa, in tune and with indication of duration, thus:

♩ = doh and 𝅗𝅥 = doh-oh

(d) Find the correct notes within the diatonic scale from middle C on the piano and sing the note to tonic solfa.

(e) Respond correctly to symbols ff, f, pp, p.

All the work done was designed to bring about the maximum repetition of pitched notes in as meaningful a manner as possible, retaining the children's interest, and evoking maximum interest and response. At this stage it is necessary to used the fixed 'doh', i.e. doh = C. This compares with the first learning stage of language, i.e. one sound to one symbol without variety.

(D) <u>The six and seven year old age group (32 children)</u>

Work with the Orff type tuned percussion instruments was covered in the same way as with the pre-school group, but with more vocalising; sessions were also able to last longer. The vocal work was based on the Kodaly method but using English nursery rhymes and folk songs. The children sang to tonic solfa from staff notation and the following durations of notes were used both in singing and playing, e.g. ♩ 𝅗𝅥 𝅗𝅥. 𝅝

All degrees of the diatonic scale were practised with each duration: (see over)

doh	𝅗𝅥 = doh	𝅗𝅥 = doh-oh	𝅗𝅥. = doh-oh-oh	𝅝 = doh-oh-oh-oh
te	𝅗𝅥 = ray	𝅗𝅥 = ray-ay	𝅗𝅥. = ray-ay-ay	𝅝 = ray-ay-ay-ay
lah	𝅗𝅥 = me	𝅗𝅥 = me-e	𝅗𝅥. = me-e-e	𝅝 = me-e-e-e
soh	𝅗𝅥 = fah	𝅗𝅥 = fah-ah	𝅗𝅥. = fah-ah-ah	𝅝 = fah-ah-ah-ah
fah	𝅗𝅥 = soh	𝅗𝅥 = soh-oh	𝅗𝅥. = soh-oh-oh	𝅝 = soh-oh-oh-oh
me	𝅗𝅥 = lah	𝅗𝅥 = lah-ah	𝅗𝅥. = lah-ah-ah	𝅝 = lah-ah-ah-ah
ray	𝅗𝅥 = te	𝅗𝅥 = te-e	𝅗𝅥. = te-e-e	𝅝 = te-e-e-e
doh	𝅗𝅥 = doh	𝅗𝅥 = doh-oh	𝅗𝅥. = doh-oh-oh	𝅝 = doh-oh-oh-oh

It was again noticed that the children found interval work much easier at this stage than the scalewise approach. It was further noticed that moving by step, appeared to be more an exercise of vocal organ control than an aural training exercise, whereas interval progressions did of necessity involve aural work. Stepwise work without interval leaping tended to encourage lazy listening, and consequently careless intonation by failing to take advantage of the child's natural acuity of hearing for pitch at this stage. This is necessary to establish maximum learning of the absolute pitch of each degree. This is I suggest, the reason behind the greater ability in sight singing with good intonation shown by youngsters of this age trained via the Pentatonic Scale, than those using only the Diatonic Scale stepwise without an intervallic approach. Descending scales also require greater placing of the voice and involves aural exercise.

The order in which pitched notes were usually learnt by the children, aged between two years and six years in the experimental groups used, was as follows:

1. 

2. 

3. 

These three notes were learnt fairly quickly. The next two, figures 4 and 5, followed after a time lag.

4. 

5. 

The learning of notes 6 and 7 followed after a longer time lag.

6. 

7. 

The last note to be learnt, figure 8, was 'b'.

8. 

N.B. When testing 600 children in the Junior and Secondary Departments of a Direct Grant School, 900 children in a Comprehensive School and 100 children in a Special Boarding School, I found only one child (aged 8 years) who did not learn middle 'C' first. This child learnt 'D' first.

With the age group two years to six years the method of testing the children's pitch learning was to play a note on either the piano or the xylophone. The children had to listen and then immediately play the correct note on their own instrument.

Continued work showed that whereas these pre-puberty children at the end of one year's training were able to identify the Absolute Pitch of these notes, some reinforcement was necessary before the notes could be pitched vocally.

Constant reinforcement was necessary to firmly and permanently establish Absolute Pitch learning. In general, it appeared that three years work was required at the pre-puberty stage, under optimum conditions, to establish Absolute Pitch Memory.

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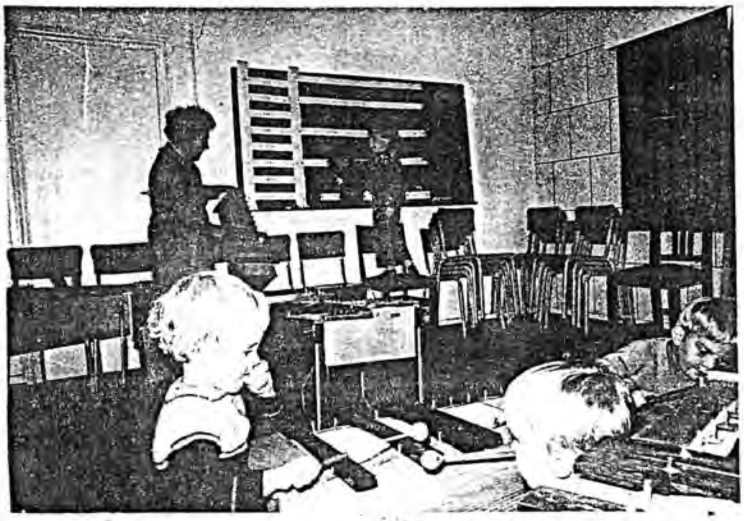

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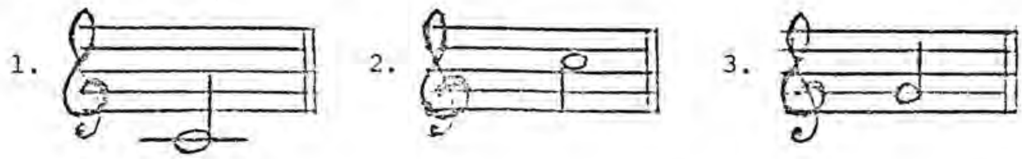

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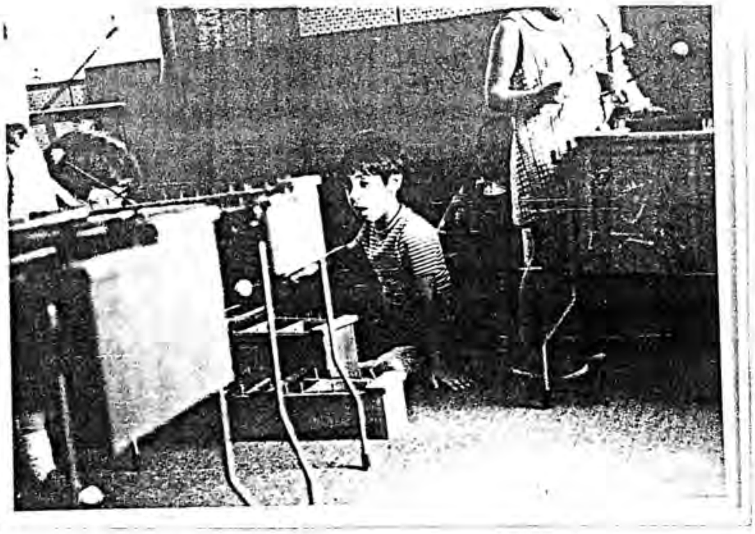
Identifying the note 'G'



Listening to the note played on a xylophone and then playing the same note on the piano

The reversibility of mental action necessary before the act of discrimination can be made has not usually begun to develop until the stage of great acuity of hearing for, and therefore pre-occupation with, the absolute pitch of individual sounds has begun to recede. Prior to the achievement of pitch discrimination, conditioning of auditory stimulus and cue is essential.

Pitch learning of children aged four years to nine years in a Worthing School, following the Vocal Training Programme

The programme was carried out for three months with a daily ten minute training session, approached scalewise and vocally.

Group of 30 children - aged four years

Notes: (a) Tired easily.
(b) Individual efforts more accurate than group work.
(c) Interval singing and recognition better than scalewise passages.

Group of 30 children - aged six years

Notes: (a) Only one child could not manage 'lah'.
(b) Individual work still better than group work.
(c) Interval singing and recognition better than scalewise passages.
(d) Drawing of ladder appeared to assist learning.
(e) Younger members of the group found difficulty in pitching above 'G' but recognised the notes aurally.

In this investigation "pitch learning" meant singing in tune with an instrument and the diagrams represent the order of learning.

Group of 23 children - aged seven years

Notes: (a) Five of the group could not yet sing 'te' in tune and were marginally out of tune at 'lah'.
(b) Within one week's training all were in tune.
(c) Interval singing and recognition more accurate than scalewise approach.
(d) Group work still weaker than individual, but signs of improvement.

Group of 32 children - aged nine years

Notes: (a) Diatonic scale sung in tune and correctly identified within first term.
(b) Sang in tune as a group.
(c) Intervals approached both rising and falling. Falling intervals learnt more quickly but not scalewise passages.
(d) Different children now capable of leading the 'drilling' session from the keyboard and being critical of the results.
(e) Notation now linking with the ladder as a means of reinforcement.

Key to the Group results

 sang in tune.

 sang slightly out of tune.

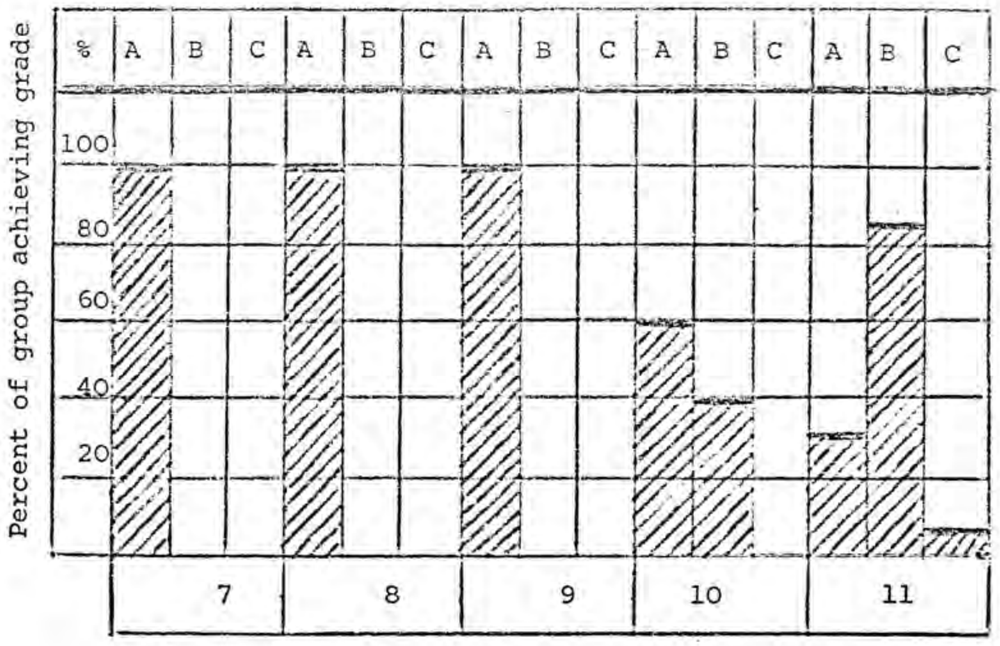
A record of the possible pitch learning of children at each age becomes increasingly important when it is realised that it is auditory memory, on which we must rely for our auditory based skills. From this it follows that children must learn the maximum possible for their stage of development, in order that their auditory memory attains full potential development.

The urgency of the problem can be illustrated by the realisation that by seven years of age non-native speakers of the English language are normally incapable of learning the 'th' sound naturally through their hearing if they have not already done so. This is the highest pitch sound in the English language with the weakest S.P.L. Fortunately once we have learnt a sound it only requires 50% hearing to recall it from our memory. This means that by seven years of age we must rely on our memory for the highest pitched sounds.

GROUP A

Pitch learning of children aged seven to eleven years using the Vocal Training Programme

Scalewise and interval work was carried out simultaneously. Sixty pupils were tested, twelve in each age group. After a one year training programme the following results were achieved.



Age in years at start of training

Results expressed in grades A, B, C, D.

A - Sight sing fluently in any key with good concentration and nil mistakes.

B - Sight sing reasonably well, but with occasional lapses of intonation.

C - Sight singing in tune only possible when singing with others.

D - Unable to sing in tune.

There was no Absolute Pitch learning at this stage, although the majority could correctly identify middle 'C'. Intelligence appeared not to affect pitch learning at this stage. National Foundation of Educational Research non-verbal Tests and Schonell's Intelligence Tests A and B were used, but the range of ability among those obtaining Grade A, B or C was from I.Q. 90 to 120.

I.Q. therefore had apparently no bearing on the grade obtained. In order to ensure that audiometrically this was a normal group of children, Pure Tone Audiometric screening was carried out using an Amplivox 51 Audiometer, frequency range 125 Hz to 8 000 Hz. It was noted however that the more intelligent of the group showed a tendency towards careless intonation. As a group they quickly grasped the academic points of a lesson and also responded quickly, but at times often without adequate listening.

Using the same group of children, numbering sixty, and following one year's work at the Training Programme, Pitch Recognition Tests were given using Novello's Modern Sight Reader, Book I. The following pitch scores were recorded together with I.Q., Personality Score and age at start of training programme.

Each child was allocated a number for identification purposes while maintaining privacy.

PITCH RECOGNITION TESTS

Number	I.Q.	Age at start of training	Personality score	Pitch Recognition score
1	100	10	2	80
2	112	8	1	95
3	90	6	1	90
4	120	10	3	80
5	115	8	4	100
6	100	9	3	85
7	100	10	3	80
8	115	10	3	75
9	110	10	3	75
10	100	10	3	70
11	100	10	3	65
12	100	8	3	85
13	100	10	3	65
14	112	10	3	70
15	115	8	1	100
16	90	8	4	95
17	115	11	3	55
18	112	11	3	50
19	110	11	3	60
20	112	11	2	15
21	95	8	2	65
22	90	8	3	60
23	110	10	3	50
24	112	11	3	55
25	115	10	3	75
26	112	10	3	65
27	115	8	3	75
28	110	10	3	80
29	120	11	3	35
30	90	11	3	65
31	90	8	3	65

Number	I.Q.	Age at start of training	Personality score	Pitch Recognition score
32	110	11	3	50
33	112	8	3	75
34	110	11	3	60
35	90	9	4	100
36	90	11	4	80
37	115	9	4	100
38	130	10	4	90
39	115	9	3	100
40	120	6	2	90
41	112	6	3	100
42	120	8	3	90
43	110	11	3	60
44	115	11	3	65
45	120	9	3	95
46	110	9	2	85
47	100	10	3	65
48	100	8	3	80
49	90	6	3	80
50	120	10	3	70
51	110	11	3	45
52	100	11	3	50
53	90	11	3	35
54	110	11	1	55
55	90	9	1	60
56	112	10	3	5
57	100	9	3	45
58	100	6	3	40
59	100	11	3	45
60	100	8	1	85

The sample correlation coefficient between I.Q. and Pitch Learning score in this age group was $r_A = 0{,}0775$ i.e. very little relationship between I.Q. and Pitch Learning at this age.

Melodic Dictation tests (Novello's Folk Song Sight Singing Series, Book I) were then given to the same group, requiring the children to write out the dictated phrases theoretically correctly. As the tests became more technically difficult (theoretically, not aurally), so the more intelligent children achieved higher scores in their ability to record accurately; albeit their aural identification remained similar to less intelligent children. It was also found that the moveable 'doh' method on tonic solfa presented more difficulty in identification with the slower children than the fixed 'doh' - their ability in 'fixing' a pitch to a given note being stronger than their ability to relate a pattern of sounds from any note.

Personality

This group of children had all experienced severe emotional stresses which had eventually led to their committal to various residential institutions for the maladjusted. As a group the majority lacked self-confidence and it was found that too early an introduction to the test situation destroyed the embryo self-confidence, and so care was taken to only drill the audio/visual cue, but give opportunity for self-criticism by private practice until the pupil asked to be tested. The standard of intonation achieved was excellent with the majority but by general observation I formed the opinion that personality could have a greater influence on pitch learning at this stage than intelligence. On testing however I found that the sample correlation coefficient

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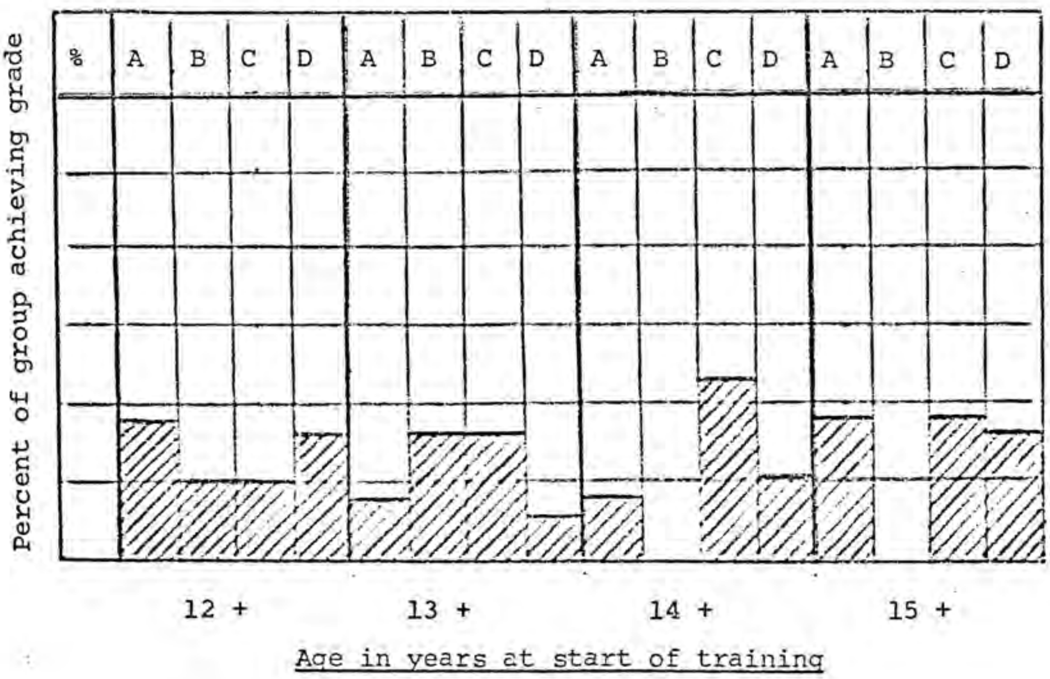
GROUP B : SENIORS

Pitch learning of children aged twelve to fifteen years using the Vocal Training Programme

Scalewise and interval work was carried out simultaneously. Eighty pupils were tested, twenty in each age group. After a one-year training programme the following results were obtained:



Results achieved expressed in grades A, B, C, D.

A - Sight sing fluently in any key with good concentration and nil mistakes.

B - Sight sing reasonably fluently, but with occasional lapses of intonation.

C - Sight singing in tune only possible when singing with others.

D - Unable to sing in tune.

An apparent lack of pattern and relationship with age at start of training was puzzling in view of that shown by the younger group A. This was investigated and produced the following important observations:

(1) All those scoring 'A' at 12 years were physically immature except two, who had received musical training prior to entry - even the group of below average intelligence scored 'A' at this age if physically immature.

(2) All those scoring 'D' at the age of 12 years were physically mature at the start of training.

(3) All those scoring 'A' from the age of 14 years upwards were either girls or had received some early musical experience.

At this stage it was noted that sexual maturity possibly affected pitch learning more than actual age. It was further noted that a second peak of hearing acuity and improved vocal quality was being regularly recorded among the physically immature group. This appeared to be happening for a few months prior to sexual maturity developing. It was only of a few months duration and appeared to be insufficient to have a permanent effect on the learning of pitch. This has also been noticed by other researchers. (Martin, M.C., 1974.)

After one year's training approximately 50% of this group were given the Pitch Recognition Tests. The following pitch scores were recorded, together with I.Q. and ages at start of training.

Number	I.Q.	Score %	Age
1	100	15	12
2	100	20	13
3	85	5	12
4	90	0	12
5	110	30	13
6	100	28	13
7	100	8	12
8	100	5	13
9	115	32	15
10	110	45	15
11	100	30	14
12	100	0	15
13	100	5	15
14	115	35	16
15	112	30	14
16	112	32	15
17	90	0	12
18	90	0	16
19	115	35	15
20	115	45	15
21	100	20	13
22	100	20	14
23	110	25	16
24	115	30	14
25	100	20	15
26	100	18	13
27	100	15	13
28	90	10	13
29	90	5	14
30	100	15	14
31	110	20	14
32	100	18	14
33	110	25	13
34	100	20	14
35	120	60	13
36	100	10	14
37	100	15	15
38	100	20	13
39	100	60	15
40	115	30	14
41	120	45	13
42	110	40	13
43	100	75	13

The sample correlation between I.Q. and pitch score in this age group was found to be $r_B = 0{,}6431$ (i.e. quite a strong relationship between I.Q. and Pitch Score with this age group).

It was noticed that scores generally were very much lower with the older group, and became more dependent on individual ability to relate a visual cue to the pitch, and to relate an interval with the opening phrase of a well known melody.

To test whether the two correlation co-efficients are the same use Fischer's z - transformation.

i.e. to test HO : ρ_B against H_A : $\rho_A \neq \rho_B$

The statistic $\left(z_1 - z_2\right)$ is normally distributed with zero mean and variance $\dfrac{1}{\left(n_1 - 3\right)} + \dfrac{1}{\left(n_2 - 3\right)}$ where n_1 and n_2 are the sample sizes and $z_1 = \frac{1}{2} \ln \left(\dfrac{1 + r_B}{1 - r_B}\right)$

$$= 0,7634$$

and $z_2 = \frac{1}{2} \ln \left(\dfrac{1 + r_A}{1 - r_B}\right) = 0,0777$

$$\text{Therefore } \frac{z_1 - z_2 - 0}{\sqrt{\dfrac{1}{(60 - 3)} + \dfrac{1}{(43 - 3)}}} = 3,3244$$

Using N (0,1) tables we find at the 5% level of significance the values: $\pm$ 1,645. Since 3,3244 $>$ 1,645 we reject the hypotheses that $\rho_A = \rho_B$ and accept that they are different, i.e. I.Q. affects Pitch Score with the older group (group B) but not the younger group (group A).

In view of the observation that sexual maturity possibly affected pitch learning more than actual age, I decided to divide the older age group (group B) into two groups, i.e. those that were sexually mature before receiving pitch training and those sexually immature, and compare their results in the tests.

Group Y - Immature, with ages approximately 12 to 14 years.

Group X - Mature, with ages approximately 12 to 16 years.

Using the Mann-Whitney-Wilcoxon test, we have the observed value of the statistic U i.e. $U_{obs} = 643$.

$$\frac{U - \frac{mn}{2}}{\sqrt{\frac{mn\,(m + n + 1)}{2}}}$$

is approximately distributed as a normal distribution with mean 0 and variance 1. (m & n are the group sizes).

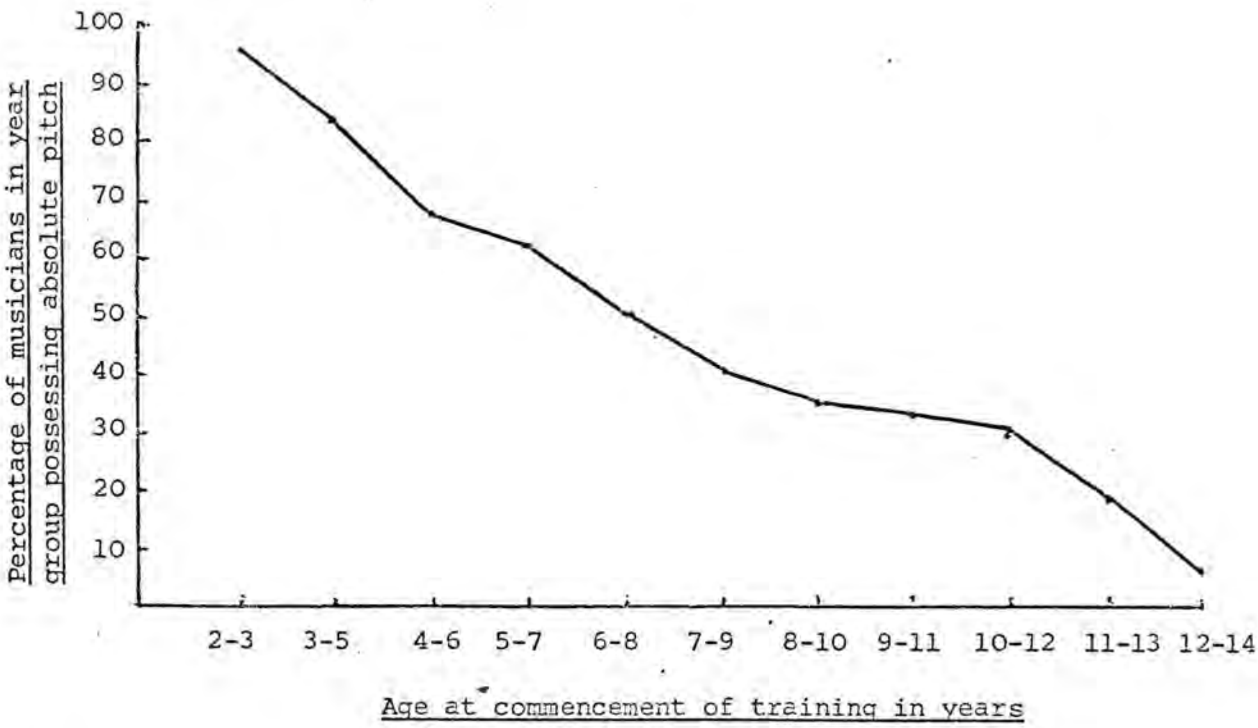
$$\text{Now } \frac{mn}{2} = \frac{43 \times 15}{2} = 322{,}50$$

$$\sqrt{\frac{mn\,(m + n + 1)}{2}} = \sqrt{\frac{43 \times 15\,(59)}{2}} = 137{,}94$$

$$\text{Therefore } \frac{U_{obs} - 322{,}50}{137{,}94} = 2{,}32$$

Compare with N (0,1) tables at 5% level of significance. Table values are + 1,645 and - 1,645. Since $U_{obs} = 2{,}32 > 1{,}645$ we reject that the groups are equally distributed and we accept the fact that sexual maturity before training affects the pitch score more than actual age.

Desmond Sergeant (1969) shows the age of commencement of training among Absolute Pitch possessors as the following.



Proportions of absolute pitch subjects amongst musicians who began musical training at each of the two-year intervals up to fourteen years.

He also observed that absolute pitch learning disappeared completely if training did not begin until twelve years of age or so, but as shown in my own work this appears to be tied to the onset of puberty and not merely to age. The big change at puberty appears to be the inability to develop a memory of individual pitched sounds to any level whatsoever. What had been learnt before puberty would be remembered and was assisted by reinforcement and relationship training, but the standard achieved was always dependent on the first learning that took place in the pre-puberty years.

Many researchers have suggested the age between six and seven years as that observed to be the most optimum for musical development.

They have then reasoned that this is when there should be the most attention paid to musical education. They have failed to realise that hearing is approximately three years in advance of vocalisation, and that what the child is expressing at six is the result of three years of listening. This failure is dangerous if it results in a lack of listening training during the first six years.

<u>The declining ability of Pitch Learning as the age of the commencement of training increases is shown in the 19 different states of pitch learning achieved in descending order.</u>

First 3 years

(a) Ability to pitch notes immediately from memory, without any cue to better than a semitone, without being faulted. (This appeared to require maximum influencing factors available in the first three years.)

These states were noted among subjects where maximum influencing factors were available during the first 8 years

(b) Ability to recall pitch notes from memory, slightly delayed response apparently assisted by a visual cue or other association.

(c) Ability to identify notes pitched immediately. Experimentation, vocalising or visual cues not being necessary.

(d) Ability to identify pitched notes with a slight delay, apparently assisted by a visual cue - the sight of the instrument often being sufficient.

(e) Identifying the pitch accurately within a semitone and not faulted more than 1 in 10 scores.

(f) Identifying the pitch as above but also allowing the subject to sit at the piano touching, but not playing the notes, or experiment vocally.

These states were noted among subjects where maximum or a reasonable number of influencing factors were available during the pre-puberty years

(g) Identifying pitched notes when played on their own instrument, but response often delayed until the next note was sounded.

(h) Identifying one note, usually middle 'C' immediately, and then the remaining notes more slowly, as if using the 'C' as a point of reference.

(i) Identifying certain pitched notes fairly quickly but often confusing adjacent notes - although this does not appear to happen when the middle 'C' is involved. The larger interval appeared to be the more accurately the pitch identified. The kind of instrument used as a source of pitch sample begins to affect the accuracy of identification.

(j) Able to identify middle 'C' and then providing sufficient time allowed it was possible to identify most diatonic and chromatic notes.

(k) Key chord necessary to establish a Tonal Centre and then it became possible to immediately pitch all diatonic and chromatic intervals. Sufficient time was necessary to allow exact placing of melodic phrases, otherwise there was tendency to occasionally have the melodic outline correct in relationship to the first note, but perhaps at the wrong pitch. Cadential Points and other attentional places usually pitched correctly.

(l) Key chords and preliminary work necessary to establish Tonal Centre which took longer than in earlier stages, but once established, chromatic work was still possible without loss of tonal centre.

Post-Puberty Development

(m) Key Chord and Preliminary work to establish the Tonal Centre makes it possible to identify Cadential Points and Intervals, providing some time is allowed for this, but often only the melodic outline is identified with the actual pitch being a tone too high or too low. Chromatic notes can only be used as accidentals - often only the flattened 7th or sharpened 4th - without the destruction of the tonal centre.

(n) With time spent on the establishment of a tonal centre and some practice on the identification of diatonic intervals relating them to known melodies, it was possible to identify pitch. There seemed however to be no further development of pitch memory since the only intervals etc. remembered, were those from previously known melodies which they had learnt to identify. Vocally, it was only possible to move to a chromatic note by semitone without losing the tonal centre.

(o) Given a sample after the preliminary work to establish a tonal centre, it was possible to obtain an accurate response during the session, but this was not remembered beyond the end of the session, i.e. played and named by the teacher, and sung by the child as shown below.

The child was then asked "What is this?"

(p) Ability acquired to sing reasonably well in tune once the tonal centre was established, but vocal or instrumental support was needed at the beginning of most phrases. Span of pitch memory was very short.

(q) Capable of singing in tune with continued instrumental support; up to 30 dB amplification of the pitch source assisted, even when the subject was audiologically normal for his or her age.

Post-Puberty Development

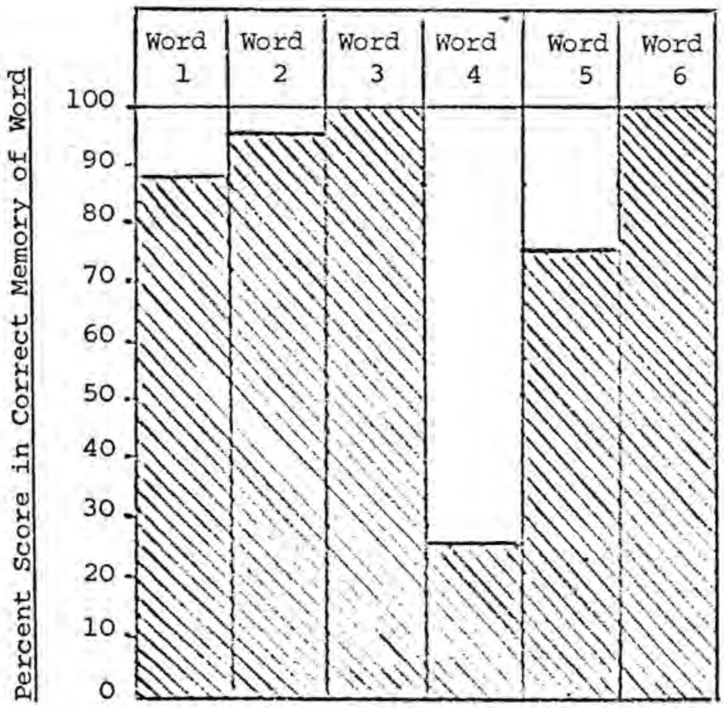
(r) Unable to sing in tune even with instrumental support, but could recognise the playing of well known melodies.

(s) Unable to 'hear' melodic outlines, each pitch appearing to be only a noise - speaking voice flat and without pitch variation, any skill involving auditory memory affected. This state was only found among those suffering from some form of hearing abnormality - usually either a sensori-neural hearing loss or a central dysacusis. Those with a conductive hearing loss, providing there was sufficient hearing to enable the sounds to be heard, had been able to learn pitch within the limits of the hearing present during the pre-puberty years.

It was found that the most accurate pitch learning was achieved when the greatest number of influential factors were present at the youngest age. The first three years appearing to be the most important. It was also found that the influencing factors could compensate partly for age but only at the pre-puberty stage.

Auditory Span - In an attempt to study the auditory memory span for temporal patterns with 30 subjects from a boys' secondary school in Rhodesia without the influence of tone, I prepared lists of unrelated phonetically balanced words in groups of six at a time. This I had found was the maximum number of unrelated words achieved by any subject in the group.

Using a Linco Trainer to present each group of words at a S.P. Level according to their individual audiograms, thereby reducing variation of stimulus to between the individuals of the group, I read each group of words. The subjects wrote them down from memory at the end of each group of six. The results are given in the diagram below:



Temporal Pattern

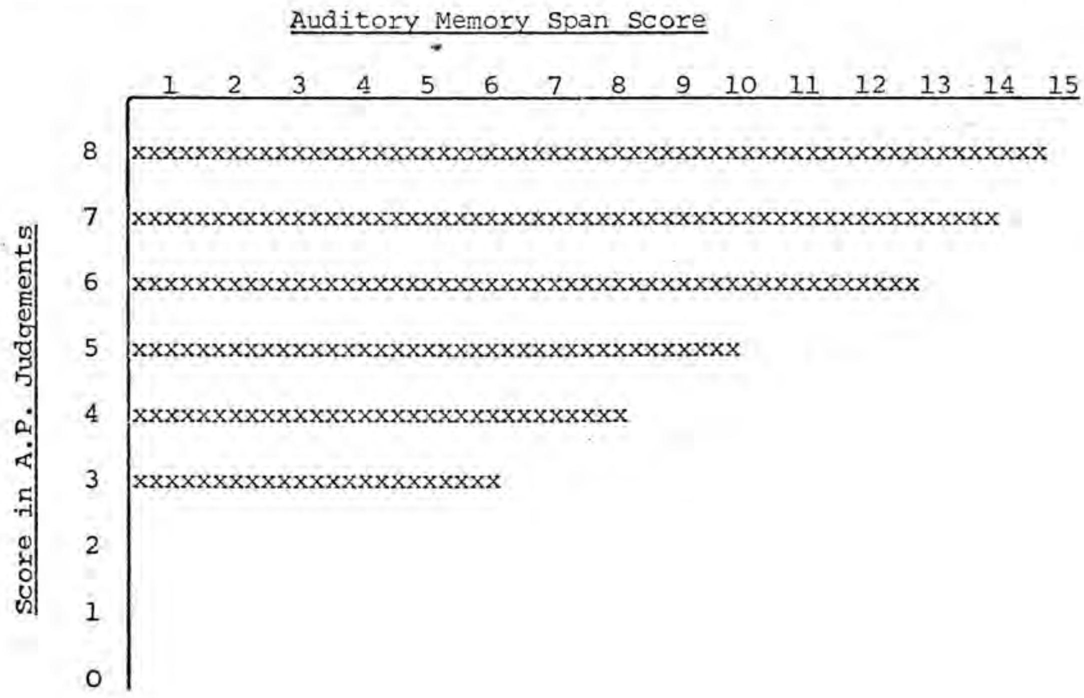
Clearly another set of phenomena when dealing with temporal fusion is involved. These findings are supported by Millikan and Darley in 'Brain Mechanism' underlying speech and language, i.e. Attentional Points (see section 'Tonal Relationships in Pitch Learning'.)

Having noticed that improvement in the learning of absolute pitched notes appeared to lengthen the Auditory Memory Span, I carried out the following test on a group of 15 music students who had received daily aural training for a complete academic year. The test was scored as follows:

(a) Two points for each note correctly identified.

(b) One point for each note in error of not more than one semitone.

A series of notes was played without any reference tone and a cluster of notes played between each test note to destroy any lingering sense of tonality. The A.P. judgement score was then listed for each subject and compared with their score in a 15 note melodic dictation. The following chart was compiled by averaging the melodic dictation score achieved by each group of A.P. judgement scores:

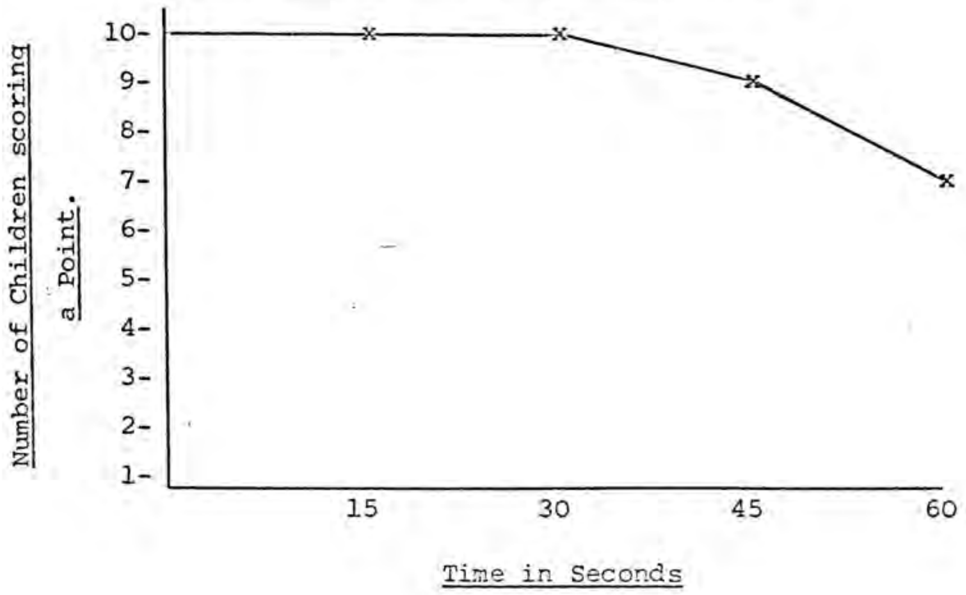


An Investigation of Pitch Memory

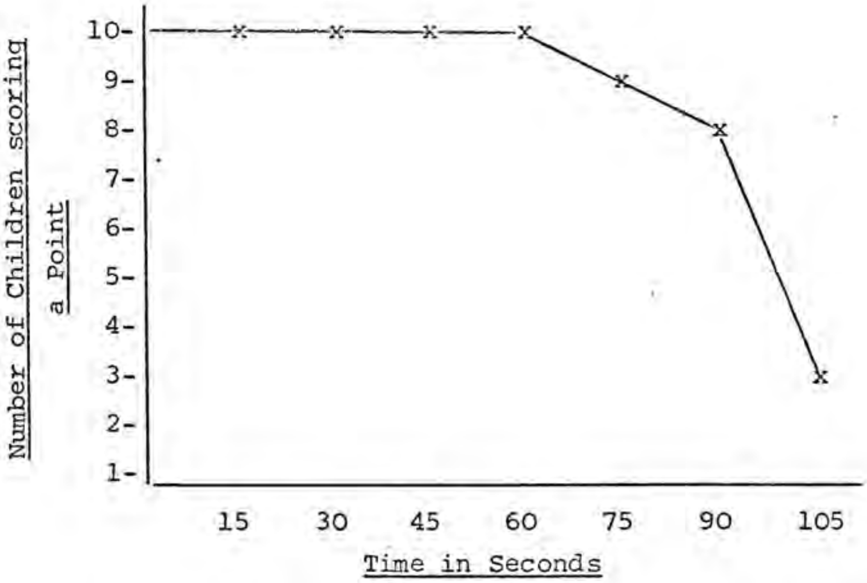
The age controlled aspect of pitch learning appears to be both the auditory memory and the actual process of pitch discrimination not affected by memory, i.e. when discrimination does not involve a memory span of longer than thirty seconds. This opinion has been formed as a result of the following experimental evidence acquired from Pitch Memory Games and Pitch Discrimination Tests. I would stress that this can only be considered as an opinion due to the difficulties experienced preventing the experiments from measuring up to the exact criteria required for controlled experiments.

Pitch Memory Games : 150 children between the ages of 5 years and 18 years without an acquired pitch memory, or previous musical experience, were given a pitched note to sing. At a pre-arranged signal they all became silent, trying only to think of the note given to them to remember. At the end of the prescribed period, they were checked individually for memory of the note, scoring a point if they were accurate.

Pitch Memory Span of Untrained Children



Group B (I.Q. 120 - 135)



Group B was observed to actively find ways of helping themselves remember the pitched sounds far more than Group A, and I suggest the improved score primarily reflects this ability, albeit that the consequence of their actions would result in a better auditory memory being acquired.

Pitch Discrimination : A comparison of 114 children's scores in the Bentley Pitch Discrimination Tests was made with their memory span.* There was a very definite correlation, as all those achieving high scores in the Pitch Discrimination Tests had noticeably longer spans with more accurate intonation. Pitch Discrimination clearly affects the acquisition of Pitch Memory.

The above experiments were then repeated with the following variation of activities taking place during the tests:

(a) Looking at pictures. (b) Listening to a story or part of one.

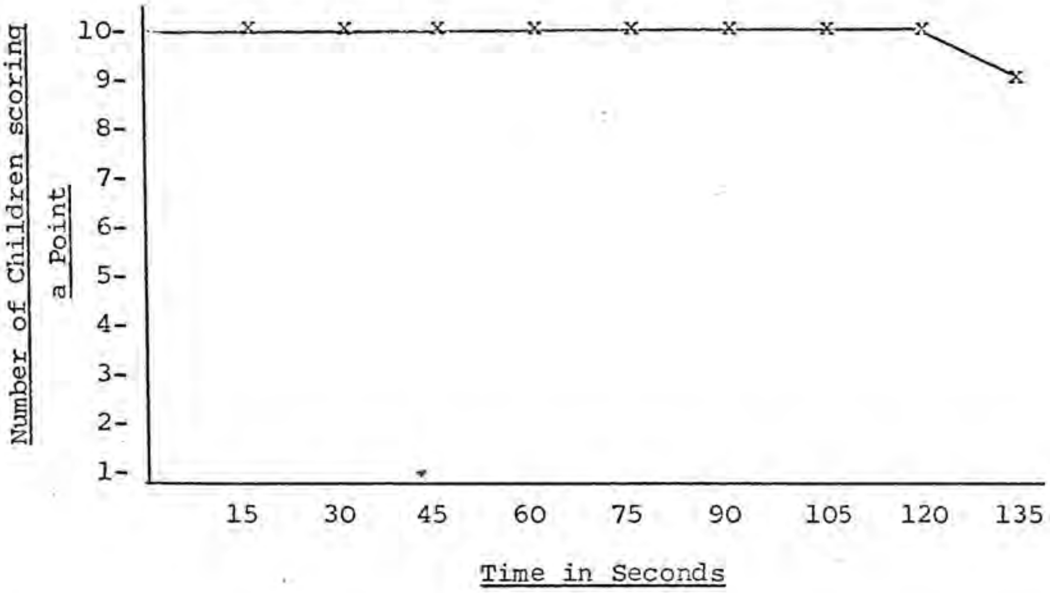
(c) Running around a room. (d) Talking to each other.

(e) Singing songs. (f) Listening to music.

(*See data on. p.147a.)

Activities (a) to (d) did not affect the Pitch Memory Span score, but (e) and (f) completely interrupted the process. This would support the earlier findings that to learn the exact pitch of a sound they must be presented singly and sufficiently often.

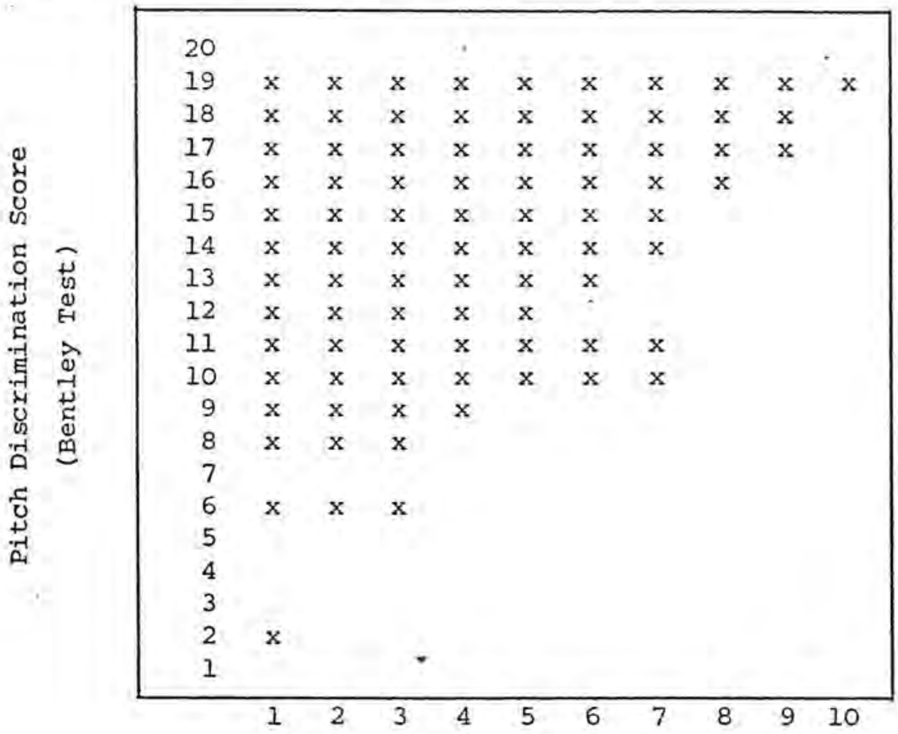
Pitch Memory Span of Musically Experienced Children



All the foregoing experiments were repeated with children who had received more than a year of musical tuition, were musically literate and able to sing easily in tune. The findings were very similar except that the Memory Span was increased to two minutes before the score began to drop. The Pitch Memory Span increased according to experience.

An Investigation of Pitch Discrimination at D.S.G. School : The Bentley Pitch Discrimination Tests were used with 114 children whose ages ranged from 12 years to 18 years; their scores were averaged according to their ages in order to assess any possible influence of age on their score. The results are shown on the next page. Following this, their P.D. scores were compared with their Pitch Memory and IQ scores. These results are also recorded on

The scores obtained in the Pitch Memory Test were grouped according to the Pitch Discrimination Score obtained by the same child and the results averaged. This graph was drawn to illustrate the relationship between Pitch Discrimination and Pitch Memory Span (short term). This work suggests that the greater the Pitch Discrimination the longer the Pitch Memory Span.

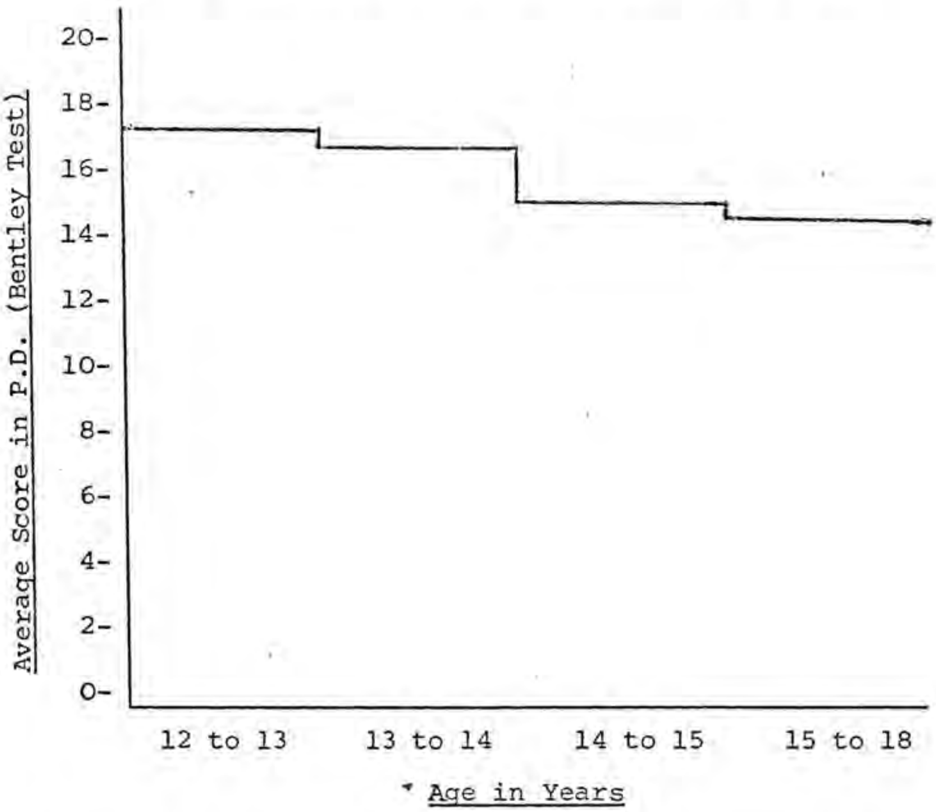


Pitch Memory Span Score (10 note melody)

Pitch Discrimination and Intelligence

Two groups, each of ten children aged 11 years, were studied. They were from similar sociological and educational backgrounds. No child had received individual musical training and both groups followed a similar state-controlled syllabus. Group A had IQ scores ranging from 100 to 120 (according to N.F.E.R. Non Verbal Test DH, 1958), and Group B from a special school, ranged from 75 to 100. (The experiment was carried out before permission was given to use the 'Special Class' syllabus when necessary.) All children were given the Bentley Pitch Discrimination Tests and the group scores average assessed. Group A averaged 15 with a standard deviation of 2.7 and Group B averaged 6.9 with a standard deviation of 1.38. Pitch Discrimination requiring an act of comparison would appear to be effected by intelligence level.

Pitch Discrimination Score of 114 Children

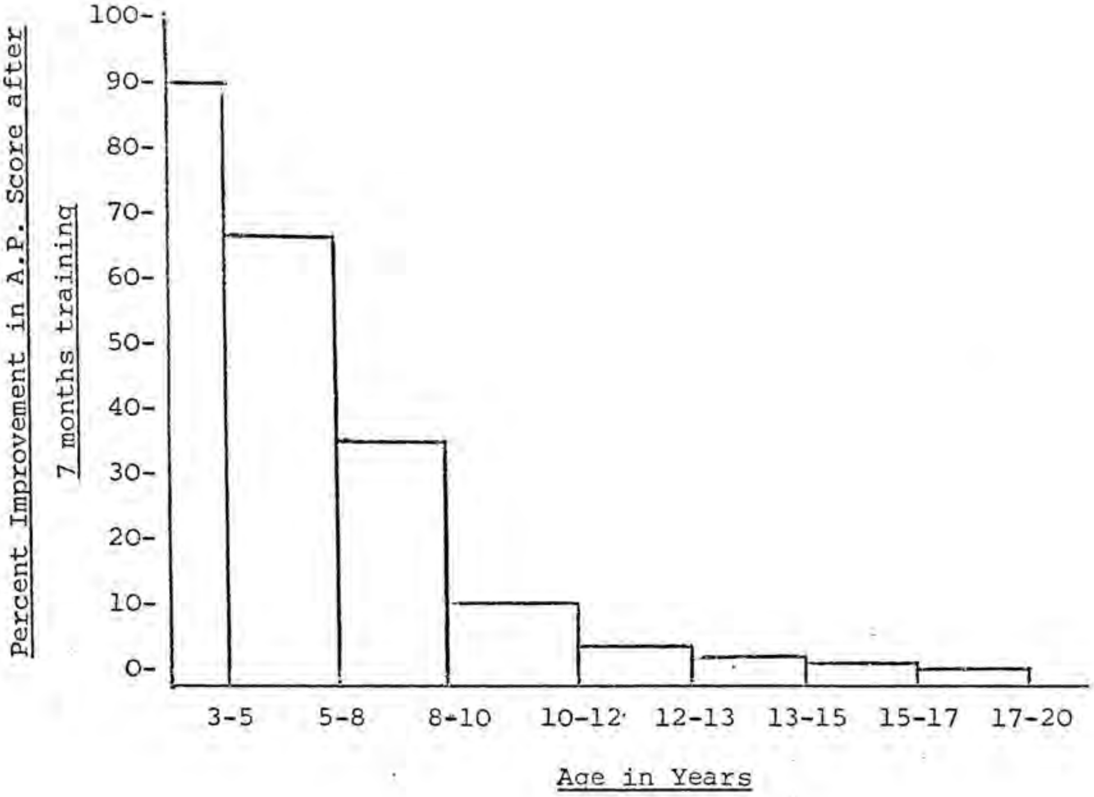


These scores suggest that contrary to the findings of others (Martin, 1970), Pitch Discrimination deteriorates with age.

Effects of Training on Pitch Discrimination : The children taking part in the investigation of Pitch Discrimination were subjected to a month's training in Pitch Discrimination of a few minutes daily, five days a week. This resulted in an overall improvement in discrimination between the smaller changes in frequency, but no one group improving more than the other. An average improvement of 2 points was recorded.

Ability to Learn Absolute Pitched Sounds : For a period of seven months the ability to learn pitched sounds was tested for a few minutes prior to each weekly training session of twenty minutes. Records were kept throughout the period to show the results and were finally expressed in the following graph:

Ability to Learn Absolute Pitched Sounds



I then compared the scores achieved in the Pitch Discrimination Tests with the scores for potential Absolute Pitch Learning Ability. This ability was assessed by comparing the scores in Absolute Pitch Memory Tests before and after the training sessions already described. The test involved the playing at the piano of single notes punctuated by clusters of notes to destroy tonality.

The following results showed both a distinct division between the Pre-Puberty and Post-Puberty Groups and the declining ability as puberty is approached.

The Relationship between Pitch Discrimination and the Learning of Absolute Pitch

When X = Pitch Discrimination Score.

When Y = Absolute Pitch Learning Score.

Ten children aged five years to eight years

X	19	18	17	17	8	19	18	9	12	6
Y	10	8	8	8	3	9	9	4	5	2

Rank

X	$1\frac{1}{2}$	$3\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	9	$1\frac{1}{2}$	$3\frac{1}{2}$	8	7	10
Y	1	5	5	5	9	$2\frac{1}{2}$	$2\frac{1}{2}$	8	7	10

Score S = 8 + 5 + 6 + 6 + 5 + 3 + 3 + 2 + 1 = 39

Total possible score = 45

Kendall's coefficient of Rank correlation

$$\tau \text{ (tau)} = \frac{39}{45} = \underline{0,8667}$$

Test for significances S = 39 n = 10

<u>0,000058</u>

e.g. <u>a very high correlation</u>

Ten children aged eight years to ten years

X	19	16	17	14	15	10	2	13	8	18
Y	5	8	7	6	4	5	1	4	3	8

Rank

X	1	4	3	6	5	8	10	7	9	2
Y	$5\frac{1}{2}$	$1\frac{1}{2}$	3	4	$7\frac{1}{2}$	$5\frac{1}{2}$	10	$7\frac{1}{2}$	9	$1\frac{1}{2}$

S = 0 + 5 + 7 + 4 + 2 + 4 + 3 + 2 + 1 = 28

Total possible score = 45

$$\tau = \frac{28}{45} = \underline{0,6222}$$

Test for significance S = 28 n = 10

<u>0,00101</u>

e.g. <u>quite a high correlation</u>

Ten children aged eleven years to twelve years

X	18	17	10	14	16	17	18	15	16	7
Y	9	10	6	9	7	9	8	7	7	7

Rank

X	$1\frac{1}{2}$	$3\frac{1}{2}$	9	8	$5\frac{1}{2}$	$3\frac{1}{2}$	$1\frac{1}{2}$	7	$5\frac{1}{2}$	10
Y	3	1	10	3	$7\frac{1}{2}$	3	5	$7\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$

$S = 4 + 5 + 5 - 5 + 2 + 2 + 3 + 0 + 0 = 16$

Total possible score $= 45$

$$\tau = \frac{16}{45} = \underline{0,3555}$$

Test for significance $S = 16 \quad n = 10$

$\underline{0,123}$

e.g. <u>very little correlation</u>

Ten children aged twelve years to thirteen years

X	15	19	15	19	19	16	16	19	20	14
Y	2	2	1	3	2	2	4	2	2	7

Rank

X	$7\frac{1}{2}$	$3\frac{1}{2}$	$7\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$	$3\frac{1}{2}$	1	10
Y	$6\frac{1}{2}$	$6\frac{1}{2}$	10	3	$6\frac{1}{2}$	$6\frac{1}{2}$	2	$6\frac{1}{2}$	$6\frac{1}{2}$	1

$S = 0 - 1 + 3 - 2 - 2 - 1 - 3 - 1 - 1 = -8$

Total possible score $= 45$

$$\tau = \frac{-8}{45} = \underline{-0,17777}$$

e.g. <u>very little correlation</u>

Ten children aged thirteen to fourteen years

X	17	16	18	14	16	18	14	11	18	18
Y	1	1	2	4	4	1	2	4	3	1

Rank

X	5	$6\frac{1}{2}$	$2\frac{1}{2}$	$8\frac{1}{2}$	$6\frac{1}{2}$	$2\frac{1}{2}$	$8\frac{1}{2}$	10	$2\frac{1}{2}$	$2\frac{1}{2}$
Y	$8\frac{1}{2}$	$8\frac{1}{2}$	$5\frac{1}{2}$	2	2	$8\frac{1}{2}$	$5\frac{1}{2}$	2	4	$8\frac{1}{2}$

$S = -2 - 1 - 3 - 3 - 3 - 2 - 1 - 2 + 0 = -17$

Total possible score $= 45$

$\tau = \frac{-17}{45} = \underline{-0,3777}$

e.g. <u>very little correlation</u>

Ten children aged fourteen years to fifteen years

X	19	17	14	9	10	16	17	14	8	18
Y	3	0	1	3	1	1	1	2	2	2

Rank

X	1	$3\frac{1}{2}$	$6\frac{1}{2}$	9	8	5	$3\frac{1}{2}$	$6\frac{1}{2}$	10	2
Y	$1\frac{1}{2}$	10	$7\frac{1}{2}$	$1\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$	3	3	3

$S = 8 - 5 - 1 - 4 + 1 - 1 - 1 + 0 + 0 = -3$

Total possible score $= 45$

$\tau = \frac{-3}{45} = \underline{-0,0666}$

e.g. <u>virtually no correlation</u>

Ten students aged eighteen years to twenty years

X	19	19	16	17	19	17	19	18	19	19
Y	10	8	7	10	10	9	5	7	8	8

Rank

X	$3\frac{1}{2}$	$3\frac{1}{2}$	10	$8\frac{1}{2}$	$3\frac{1}{2}$	$8\frac{1}{2}$	$3\frac{1}{2}$	7	$3\frac{1}{2}$	$3\frac{1}{2}$
Y	2	6	$8\frac{1}{2}$	2	2	4	10	$8\frac{1}{2}$	6	6

$$S = 3 - 1 + 4 - 4 + 2 - 4 - 1 \dotplus 2 - 0 = 1$$

Total possible score = 45

$$\tau = \frac{1}{45} = \underline{0{,}0222}$$

e.g. virtually no correlation

A comparison of these results would indicate that the scores of the Pre-Puberty groups showed:

(a) An overall 50% improvement, as the results of training, on their score in absolute pitch learning.

(b) A distinct and positive correlation between the score achieved for Absolute Pitch learning and their Pitch Discrimination score.

(c) A distinct relationship between their auditory thresholds as established by Pure Tone Audiometry and their Absolute Pitch score, although the threshold at which a response was evoked varied considerably among the children. The important factor being that the response was evoked sufficiently often and not at what S.P.L. it was evoked.

It would therefore appear that what the pre-puberty child could discriminate between is that, given sufficient opportunity, he or she can learn.

The scores of the Post-Puberty groups suggest that at this age there is little relationship between a subject's current Pitch Discrimination ability with the standard of Absolute Pitch learning achieved. Additionally it was noticed that in contrast to the overall average of 50% improvements in the Absolute Pitch learning during the programme of training, shown by the pre-puberty group and illustrated in the graph entitled 'Absolute Pitch Learning Score', <u>the post-puberty group recorded a mere 0,02% improvement</u>.

A study was then made of the speed of pitch identification by the student who appeared to be acquiring Absolute Pitch; the student concerned is mentioned in the section dealing with 'the visual aspect of pitch learning'. She was tested daily at 13.50 hours for five weeks and her scores recorded. It was found when arranging the pitched notes in ascending order according to the average reaction time, they were in the same order as that in which young children appeared to learn them. The following illustrates this finding:

0,7 1,1 1,3 1,4 1,5 2,1 2,2 2,3

<u>Average identification time in seconds</u>

It was further recorded that during a short period of respiratory infection the student lost all sense of pitch, with the exception of that for Middle C, and after a delay, for C'.

<u>Pitch Discrimination and Tonal Memory</u> : The same children were also tested for Tonal Memory. Throughout the age range there was a definite correlation between these two abilities. The results shown below were those of the eighteen years to twenty years age group;

the oldest group. The Bentley Tests 1 and 2 were used to test Pitch Discrimination and Tonal Memory. The results were as follows:

When X = Pitch Discrimination Score.

When Y = Tonal Memory Score.

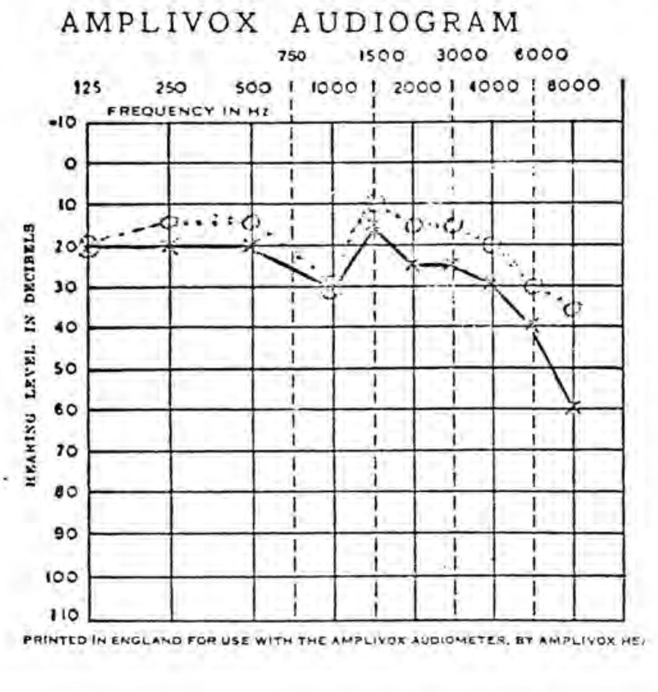
X	19	19	16	17	19	17	19	18	19	19
Y	10	10	8	9	10	10	10	10	10	9

$\overline{X}$ = 18,2 SX = 1,1353 SY = 0,6992 SXY = 0,5333

Correlation co-efficient = 0,6719

This correlation suggests that if a subject can discriminate between sounds although he may not remember the Absolute Pitch, he can remember the relationship between those sounds to the limits of his auditory span.

It is perhaps significant to note that of the ten music students tested for Absolute Pitch, only one student had failed to acquire any degree of Absolute Pitch. This was in spite of fulfilling the majority of the conditions for such acquisition. The student in question was the only one whose Pure Tone Audiogram was sub-normal at the time of testing, and whose case history suggested that the threshold had been sub-normal from birth. Given below is a copy of the sub-normal audiogram:



Notice the hearing loss for the high frequency sounds.

The foregoing section dealing with the Age Factor in pitch learning suggests very strongly that children deprived of the chance of acquiring a pitch memory during the pre-puberty years are permanently so deprived, and their chances of becoming musically literate are seriously hampered.

As a result of this Secondary School Music Education is in a state of compromise, since the development of many of the basic skills required for musical activities are dependent entirely on what foundations have been laid in the pre-secondary schools.

In spite of this, however, educational authorities continue to delay the provision of an adequate music education until the Secondary School stage and there is little provision for specialist music training for the Primary and Nursery school teachers.

It is left to Music Educators like George Self, Murray Schafer, Keith Swanwick, Brian Dennis and John Paynter to devise courses of music that will enable Secondary School pupils to participate in some form of musical activity. Much of this work, however, must remain solely an exploration of the process and procedures (Cady, H.L., 1976) of music making since the 'materials' (Langor, J., 1960) cannot be acquired because of the lack of music literacy. In my opinion Brass Bandwork, the making and playing of simple instruments etc. could be a means of acquiring some of these 'materials' in a manner suitable for the Secondary stage level of interest. A study of processes and procedures in isolation must surely eventually lead to frustration!

SUMMARY OF SECTION III

The hearing mechanism of the child is fully developed by the sixth month of pregnancy making it possible that the child is born with three months experience of sound.

Children are aware of pitch variation in sounds during the first year of life. By observation this awareness appears to be present from birth, but I have found it difficult to obtain adequate photographic evidence of this until approximately the eighth month of life.

The main problem in Absolute Pitch learning appears to be the difficulty of retaining the child's interest for sufficient length of time to permit learning to take place at the stage when Absolute Pitch learning in its most accurate form is possible. This is made more difficult because the child, at this stage, loses interest in the sound once it becomes familiar unless it has become important and therefore interesting to him. Importance seems limited to basic needs, i.e. food, mother's voice, etc. If the child loses interest in the sound it will ignore it and learning therefore will not take place. The hearing of a normal young child is very sensitive - loud sounds are disliked. Babies show a preference for high pitched sounds.

Mother/mother substitute and child relationships are vital to learning as a response to stimuli must be evoked, the mere presence of stimulus is not sufficient. Many sources of pitch response are non-sound, but involve a memory for the pitched sound, i.e. pet dog enters the room, child imitates an earlier sound made by the dog.

Monosyllabic pitched sounds must receive considerable vocal practice before two syllable sounds can be expected. The sounds once learnt are repeated at the same pitch.

The child is born with an acuity of hearing for sounds of fixed pitch. It retains this if importance can be introduced to each pitched sound and so maintain the child's interest for sufficient length of time to enable Absolute Pitch to be learnt. The ability to learn Absolute Pitch to the most accurate level possible seems to be retained for approximately the first three years of life, from that time it steadily declines. With each pitch variation there must be a corresponding variation of pleasurable, meaningful and direct experiences. The lack of opportunity to relating meaning to single fixed pitched sounds during these early years and over-insistence on 'properly structured sentences' at too early an age can result in language and learning disorders.

A developed pitch memory is vital for language development.

Absolute Pitch acuity noticeably fades as language develops but could be fading from birth.

The Soprano and Alto Xylophone appeared to be the most suitable for the two to three year old group commencing with the middle 'C' and 'G' tone bars. Aural discrimination presented no problems but the terminology 'high and low' or 'bottom and top notes' were needed to be used. Neither letter names nor Tonic Solfa could be successfully used at this age, but the pitch of the note was learnt very quickly.

A cardboard ladder with two rungs on it was compared with the xylophone on which was placed the two corresponding tone bars. By sticking a cut-out cardboard note on the top rung of the cardboard ladder the children could respond by playing the top tone bar - likewise with the bottom rung. In this way both notation and spatial elements were introduced. 'E' was satisfactorily introduced in the same way. The problem with this age group was retaining their interest after they had learnt to identify a sound. The three to four year old age group were able to eventually relate the Tonic Solfa names to the notes introduced using the terminology 'high, low, bottom, top' etc.

At this stage the children gained confidence and their ability improved in naming and playing notes instead of losing interest. The children could play or sing notes placed on the stave singly, but could not read phrases from left to right.

The four to five year old age group were able, with a little help, to read phrases from left to right. They began to cope with the recognition of the duration of notes simultaneously with their pitch and were able to recognise and respond correctly to ff, f, p, pp.

Children found Interval work easier than Scalewise work at this age. The singing of Intervals involve aural work plus vocal organ control whereas Scalewise progress can be more an exercise of vocal cord stretching - similar to the sliding scale of speech (non-tonal). Individual work is better than group work up to about seven or eight years of age. Children of seven and eight years of age all learnt to sing in tune and identify pitch regardless of standard at the start of training; but no Absolute Pitch learning was recorded. Intelligence was not related to pitch learning at this age; personality also did not appear to affect Pitch Learning. There was no Absolute Pitch learning after puberty; only Relative Pitch could be developed. The accuracy of Relative Pitch learning, i.e. the exact placing of the phrase, was dependent on the degree of Absolute Pitch acquired. Puberty affects the position more than actual age. In igence affects Pitch Learning after puberty, no doubt becaus is Relative Pitch development at this stage.

Auditory ory Span appears to be related directly to the degree of Absolute Pitch learnt. It would also appear that both the ability to acquire Absolute Pitch Memory and Pitch Discrimination declines with age.

Some tentative formulations by Gesell and Ilg (1949) on developmental gradients in music include the following, and are based on behaviour observed. They are classified as vocal, rhythmic and listening:

Vocal - At eighteen months shows spontaneous humming or singing.

Rhythmic - At two years swaying, swinging of arms, nodding head and tapping feet to music.

Listening - At four years enjoying and identifying melodies.

Some observations alleged to be typical of successive ages:

Five years - Enjoys repetitive advertising jingles on radio.

Six years - Enjoys own recordings.

Seven years - Craves piano or dancing lessons, likes to use percussion instruments.

Eight years - Less desire to practice the piano - may like to change music to own invention.

Nine years - Applies himself to practising music.

Rogers found popular music chosen increasingly at each stage and classical music less and less.

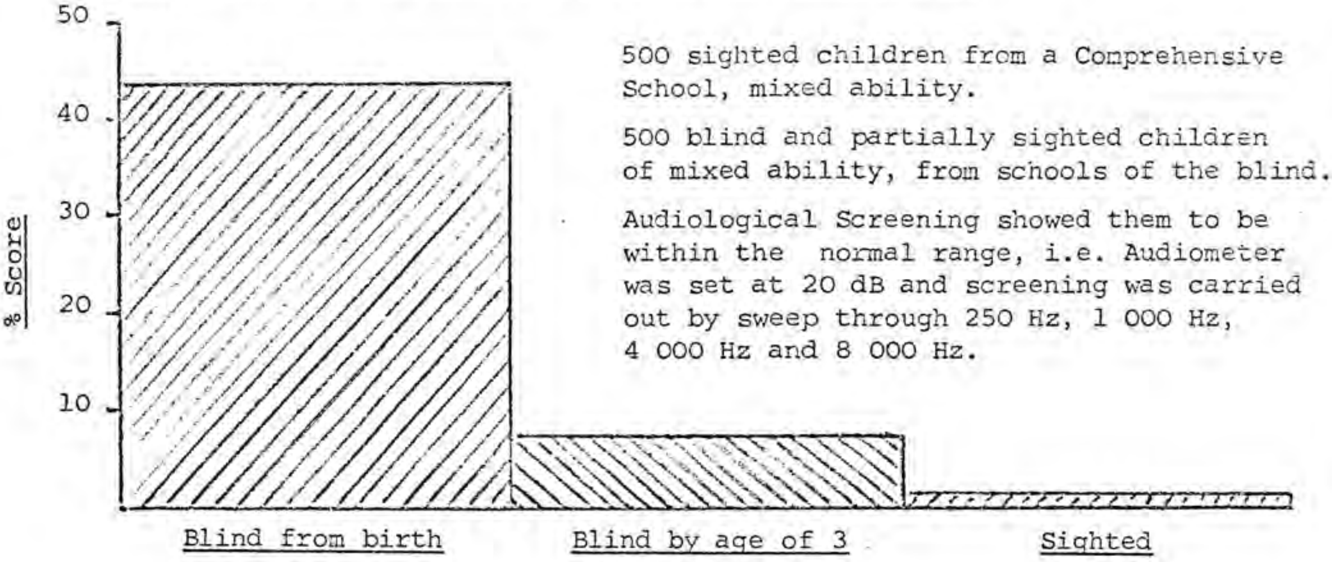
SECTION IV

INFLUENCING FACTORS

ENVIRONMENTAL INFLUENCE ON PITCH LEARNING

Sergeant suggests that the presence of A.P. in a subject, indicates that pitch has been important for him and this might mean a high level of musical awareness developing, therefore it was a manifestation of high musical ability and consequently of prognostic value. However, in my opinion importance might be based on basic survival need and not on aesthetic need, in which case any environment requiring pitch discrimination for basic survival purposes would result in greater A.P. learning. John Blacking in his essay, 'Towards a Theory of Musical Competence', states that 'musical behavior is generated by intellectual and interactional processes common to all men, stimulated by some or all of the basic animal drives of self-preservation, reproduction, respiration and exploratory behavior'. In order to test this hypothesis I chose two possible environments where pitch had meaning for basic survival purposes during early childhood. The one example was the tonal speaking groups where meaning is based on the pitch of the vowel entoned, and the other where children were born blind and relied on pitch for information about their immediate environment.

Comparing the Absolute Pitch Acquisition of children born blind, those with normal sight and those acquiring blindness.*



The charted results show that of the children who were born blind and relied on pitch discrimination during the first three years of life for information about their surrounding environment, some 42% had acquired Absolute Pitch. Those going blind after the age of three were as a group, still in advance of the normally sighted child, but showed a dramatic drop in the A.P. learning. With the normally sighted group only one child had acquired Absolute Pitch.

In an experiment designed to assess the incidence of A.P. among the normal European community, I tested 1 120 children between the ages of eight and twelve years of age using the Girl Guide and Brownie Packs in the Home Counties of England. The children were neither screened audiologically nor assessed for Intelligence Quotient. Sixteen children were found to have acquired Absolute Pitch, accurate to within a semitone at least nine times out of every ten tests; the tests were given at the piano. Approximately one child in every seventy children, or expressed as a decimal, 0,014 children of the normal European community were found to possess Absolute Pitch.

(*Questionnaire in Appendix.)

Exploring this further, I found the following:

Total Children Tested	Instruments Played by Child				Parents Played	Absolute Pitch Learnt	Sang in Tune	Read Music
	Wind	Violin	Guitar	Piano				
1 120	538	73	99	162	205	16	624	478

The sixteen Absolute Pitch subjects had the following in common:

(a) They all played the piano.

(b) They all had parents or relatives living in the house who played an instrument.

(c) They all sang in tune to an instrument (even when the instrument was out of tune) - at this stage then they were able to vary the pitch slightly.

(d) Fourteen of them read music fluently; two of them repeated phrases at the exact pitch a week later, and were thus assessed as having A.P. although they could not name the notes.

<u>General Observations</u>

(a) 1 120 children were tested and the greater number (538) played wind instruments, mainly the Recorder. Of these 538 wind players only three acquired Absolute Pitch and each of these also played the Piano. No child playing a wind instrument on its own had acquired Absolute Pitch.

(b) In the same group of 1 120 children, 73 played the violin - eight of these had acquired A.P. but again they also learnt the piano.

(c) None of the children learning the guitar had acquired A.P.

(d) Whereas all sixteen children who had acquired A.P. had parents and/or relatives playing an instrument in the immediate environment, a further 189 children had parents who played an instrument, yet they had failed to learn A.P. Additionally, 462 could read music, 608 sing in tune, 146 play the piano, all without acquiring Absolute Pitch.

<u>Acquisition of Pitch by Tonal and Non-tonal speaking groups in Africa</u> : In European languages the vowel sounds tend to be the least critical features and a considerable frequency range is tolerated. The pitch of a voiced sound is raised or lowered by increasing or decreasing the contractions of the vocal cords. If therefore, changes of pitch within vowel sounds are not critical, the process of training a child to speak will not involve the reinforcement of the 'quantitatively exact responses' of the vocal cords to frequency changes that is needed for the singing in tune.

There are however, many languages in which the meanings of words are largely dependent on intonation of the voiced sounds, and so the child must learn to determine the tension of the vocal cords in order to communicate. It is significant that so-called tone deafness in the absence of physiological defects is virtually unknown in communities using such a language, i.e. the Tonal speaking group.

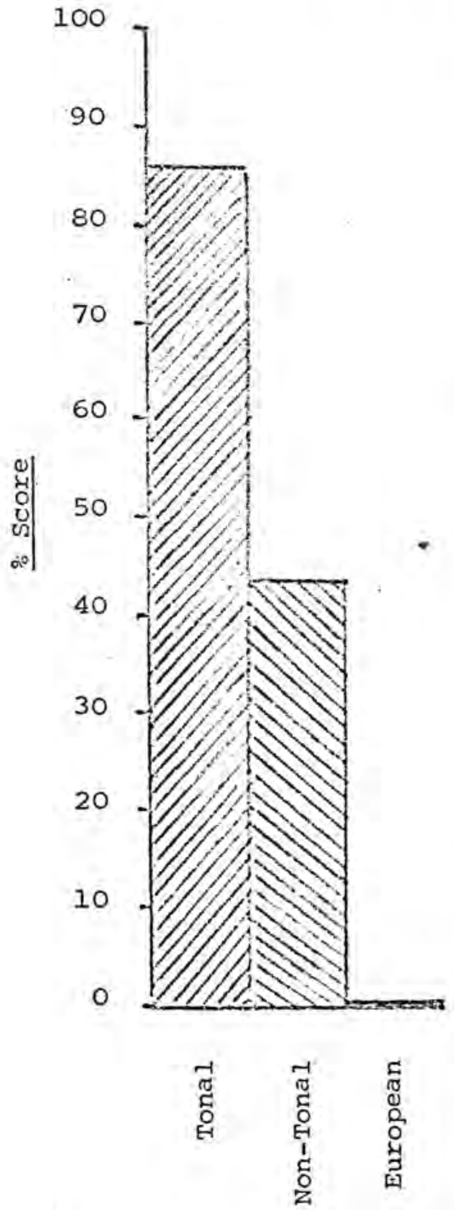
In order to observe the early training of the young in both tonal and non-tonal speaking tribes, I spent almost two years in the bush observing and recording the methods of training the children and the resultant progress. I collected material and tested some 97 different tribal groups in South Africa, Botswana, Rhodesia, Zambia, Swaziland and Lesotho, working with both tonal and non-tonal speaking groups. Generally, I noticed that during the first six to eight months there was little difference in the babies' response to sound to those I had observed in England. Babbling developed in the same way and there was no evidence of any greater acuity of hearing for pitch or special facility for pitch learning than with the European children, but when they started to experiment with more than one sound and form speech sounds, there appeared to be far greater attention to the pitch of each sound. This appeared however only to result from the mother's attention to pitch, as she was teaching the child throughout the day, constantly repeating very small phrases. There was no doubt that the children were learning absolute pitch and the reasons which emerged as I observed were as follows:

(a) The language demanded it.

(b) A great deal of practice went into satisfying the demands of the language.

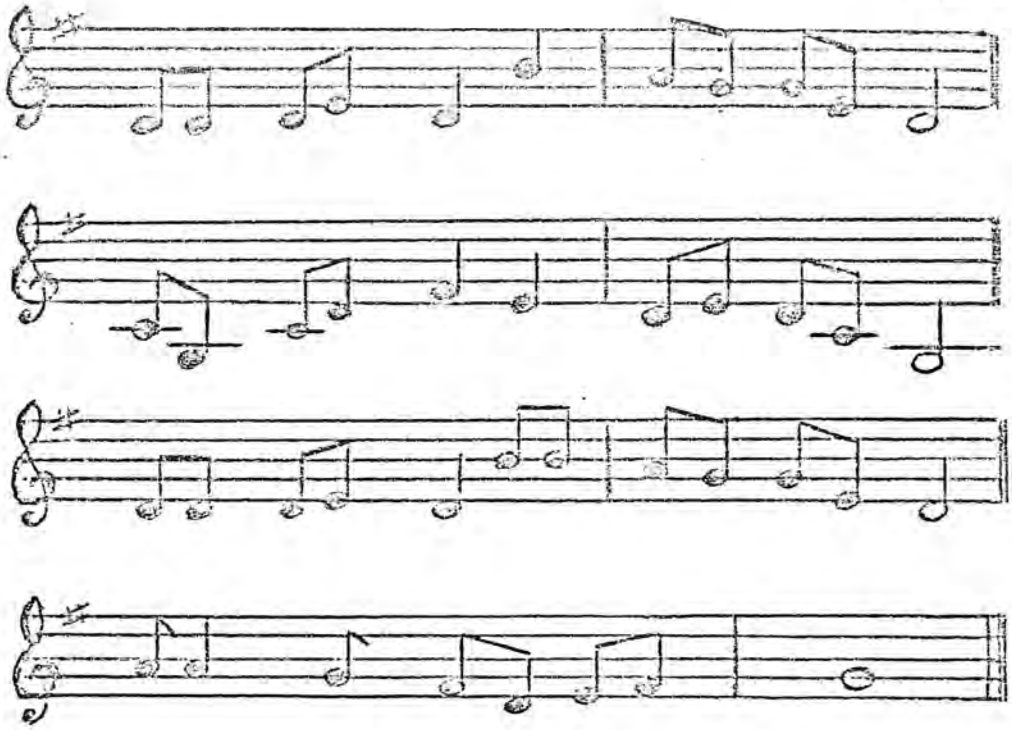
(c) A far smaller vocal range was initially explored.

The material collected all supported the finding that regardless of race, if pitch training took place in the pre-puberty years, then it was successful in establishing a pitch memory and the earlier the training began the more positive was the learning of absolute pitch. This work was carried out with the assistance of the Department of African Languages, Cape Town University, Groote Schuur Hospital, Tigerberg Hospital, Johannesburg Hospital, Speech and Hearing Clinic Pretoria, Harari Hospital. The broadcasting stations in Lesotho, Zambia, Swaziland, Botswana and Rhodesia kindly assisted with recordings. His Majesty Sobbluzu II, King of Swaziland, generously gave me permission to make recordings of traditional music in Swaziland. The Needler Westdene Hearing Organisation were most helpful in loaning equipment. Many Tribal Chiefs, Mission Hospitals and Schools assisted in the collection of material and the Meat Marketing Board often provided transport to remote areas.



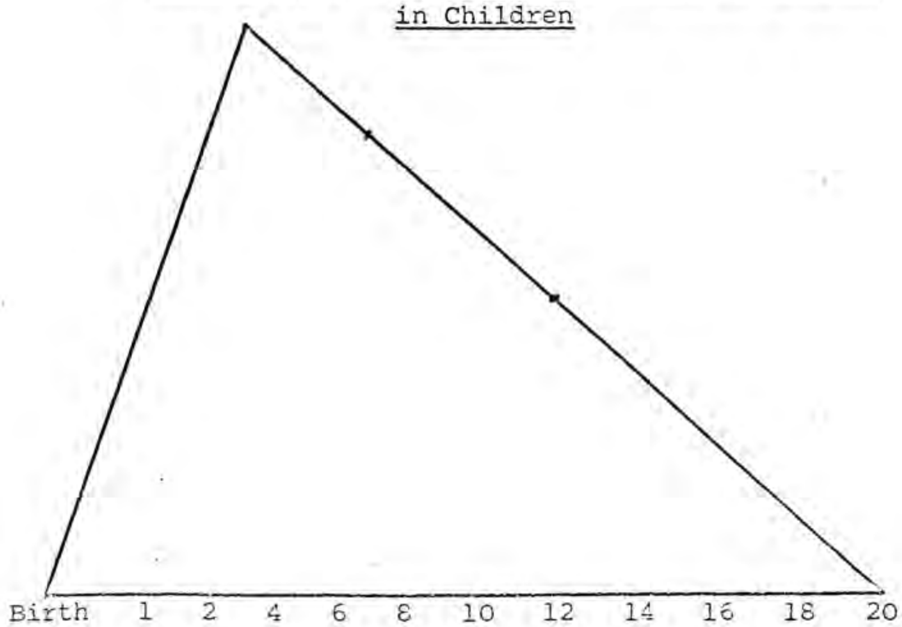
A total of 11 120 were tested; 10 000 children in Africa and 1 120 children in England. Testing was carried out by the teaching of melodies and then checking over a period the ability to sing from memory at the exact pitch. The checking was carried out by means of tape recordings, the accuracy of which was governed by the use of a sound level indicator and pitchmeter. The tunes used were first collected from the Village Elders (i.e. the actual tune used when working with the Bemba tribe was the tune illustrated on the following page). The use of music belonging to each tribe was done to ensure equality of opportunity in scoring.

BEMBA



It was found that in spite of the very high incidence of damage to hearing from disease, malnutrition, insects, etc., the tonal speakers of Africa were considerably in advance of the European children in that some 85% appeared to have Absolute Pitch as against 0,01% of the European population. I was surprised to notice that the Non-Tonal Tribes also had a relatively high standard of Absolute Pitch learning, i.e. approximately 42%. This would appear to be as a result of early involvement as I noticed that all children, until they could walk, were carried on their mother's back all day even when the dancing and singing, which took up a major part of their time, was taking place. Every basic function of life was expressed in singing and dancing and a great deal of practice went into this. In many of these groups dance, singing, gesture and speech were all described as language. It has been claimed by some psychologists that the limited vocabulary of these tribes must effectively limit intellectual development. These psychologists have failed to understand how the vocabulary is extended via pitch variation of the vowels, dance, gesture, mime, drumming etc. to a very broad vocabulary which is completely adequate for the greatest intellectual development. They sang and danced about the basic functions of life, from washing their faces to the great dramas of childbirth, circumcision, puberty, marriage, war, love, etc. Pitch was used to express extremes of emotion at this basic functional level which contributed to the degree of pitch perception shown by even the non-tonal speaking tribes. As mentioned previously, babies were involved in this from birth because they were physically carried, until they walked, by the mother whatever her activity. They therefore had maximum auditory stimulation in a meaningful manner during their optimum years for learning sounds. These optimum years are shown in the following graph as being the pre-puberty years. I disagree however with the graph showing the climbing up to the age of three years for maximum facility in the learning to recognise new sounds. In my opinion this facility is present from birth in all normal children and then gradually drops from the age of three years.

<u>Facility for Learning to Recognise New Sounds in Children</u>



<u>Age in Years</u> (According to Whetnell & Fry)

(At Bulawavo Music College it was noticed how quickly Africans learnt Tonic Solfa, the idea of pitched vowel sounds being part of their language. The principal of the college told me of missionaries who taught hymns with conventional tunes but translating the words into traditional language, failing to understand that the variation of meaning according to pitch, made nonsense of the hymns, with the result that the missionaries were labelled 'the funny men'.)

It is possible that even with the non-tonal African tribes, the nature of their language helps in pitch learning since each vowel sound is clearly enunciated and pronounced as it is written. (It is the vowel sounds that even in non-tonal languages are likened to musical chords.) A European language equivalent is the Italian language, perhaps this explains the number of Italian singers of worth. Remembering that musical sounds are perceived as louder than non-musical, any language demanding clear vowel enunciation would assist pitch learning.

The pitch of a sound depends mainly on the fundamental frequency, accordingly when there is a variation in the rate at which pulses are produced by the vocal cords, there will be a change in the pitch although no change in the formants and hence no change in the chords quality. In 'musical terms you can say corresponding to each vowel there is a chord that is characteristic of that vowel'. (Ladefoged)

The relationship between learning and need, is further illustrated by the way the baby responds to the 'need' sounds first, i.e. preparation of food, mother's voice, etc. A study of the growth of word classes, provides further illustration since it can be seen that the 'need' words (nouns) are the first to be learnt, with the next 'need' word, the verb, being the second to be learnt, and so on.

A suitable study of this was made by Valentine, Kellner, Pringle and Tanner in 1942.

The Growth of Word Classes

Age in years and months	Nouns	Verbs	Adjec-tives	Adverbs	Prepos-itions	Pro-nouns	Conjunc-tions
One year	4	1					
One year & 2mths	15	1	1	1			
One year & 4mths	39	6	2	2	4		
One year & 6mths	80	12	9	1	4		
One year & 9mths	193	51	28	7	7	1	
Two years	349	111	58	7	11	8	1
Two years & 6mths	410	140	85	25	12	13	8
Three years	571	201	129	53	23	17	11

I found two contrasting situations to study, one where the daughter of a composer had developed a love of music and as a result her child was surrounded by music from birth (Elgar), and the other whose son was tired of a household revolving around music and so his children apparently heard little music at home (Vaughan Williams). In the first case the child had a very good sense of Absolute Pitch, but the latter case showed that both children could not even cope with simple tests of relative pitch at the end of a year's training from the age of fourteen. This would support the view that the availability of music in the early environment has greater influence on the acquiring of Absolute Pitch than innate ability.

In Desmond Sergeant's work the effect of parental ability to play an instrument on pitch learning is shown in a graph. With both parents playing the score was 35,3%, with the mother only playing it was 30,4%, and with the father only playing it was 13,5%. Again this stresses the <u>immediate</u> environment at the optimum age, since it would normally be the mother who would be at home playing the piano during the hours that the young child would be available. At least one parent played an instrument in 79,2% cases. The immediate environment aspect as against inherent ability, is again emphasised in a study of the figures of A.P. subjects of the profession of musicians for parents. In this case 11,2% of the parents who were professional musicians were mothers and 10% were fathers, thus slightly over 21% had one parent or the other as professional musicians, but slightly less than 79% had neither.* I suggest this further indicates that it is the availability of performance for the child to hear and be encouraged to copy rather than any sex differential affecting hereditary trait. The large percentage having neither parent as a professional musician further illustrates the value of evoked response and training, since in my experience I have found that whereas a child hears plenty of instrumental practice and performance from the parents when they are professional musicians, they rarely have the benefit of a sensibly planned training to meet their own developmental needs. See Justine Ward's work on the kind of music teacher required in the Primary School; this can be found in the section dealing with the consideration of Teaching Methods. Frequently the children tend to reject the music made by their professional musician parents if it appeared to be, that in the opinion of the child, more important to the parent than to the child. Rejection is clearly a barrier to learning.

(*See the work of Schuter, R., 1964.)

The importance of the immediate environment in learning through hearing is I suggest further illustrated by the number of children with 'learned' speech defects. I have often found children whose speech gave every appearance of being the result of a high frequency deafness but when tested by routine Pure Tone Audiometry had no such hearing loss. I then found that a parent had such a hearing loss and the child appeared to have 'learnt' the defective speech.

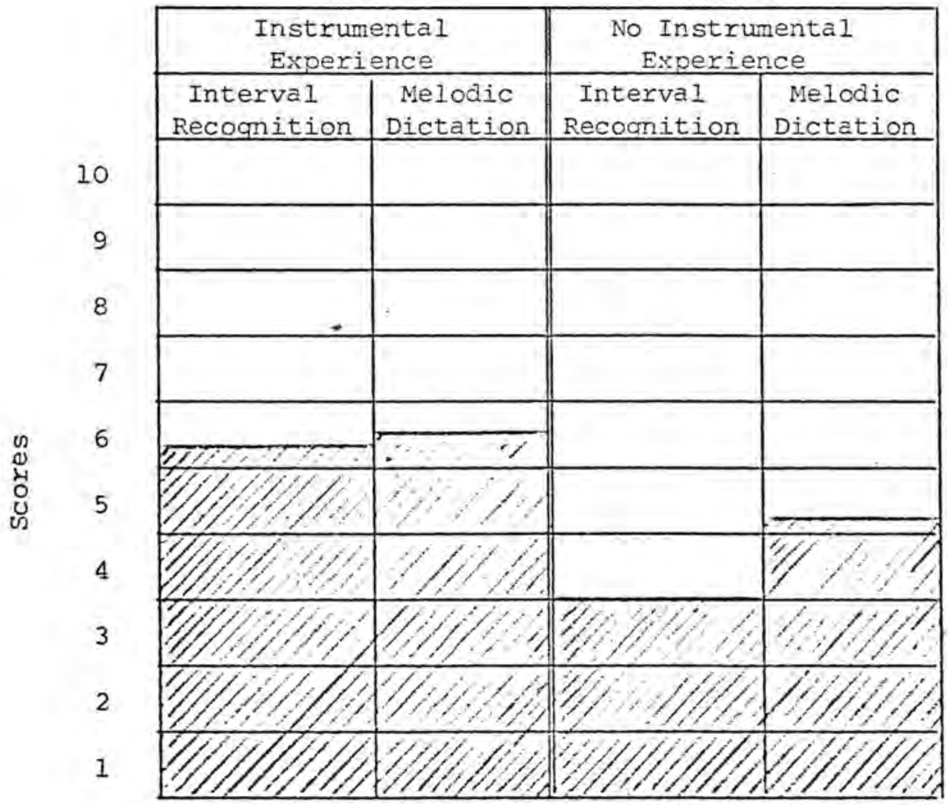
The rejection of music as an unpleasant experience can also be caused by sensori-neural hearing losses. To a subject with such a loss music would be distorted and could be perceived as an unpleasant, even painful noise.

This was vividly illustrated in the case of an elderly man who came from a musical background but claimed to detest music as it was an unpleasant noise. Audiometric tests showed a severe sensori-neural loss with recruitment. The man's description of his reaction to music in his childhood suggested that this loss had been present at that time and had resulted in music being such an unpleasant experience to him that he had developed an intense dislike for it and had avoided it whenever possible.

The provision of a Selective Hearing Aid with Peak Clipping for the lower frequencies and with Automatic Volume Control might have prevented this.

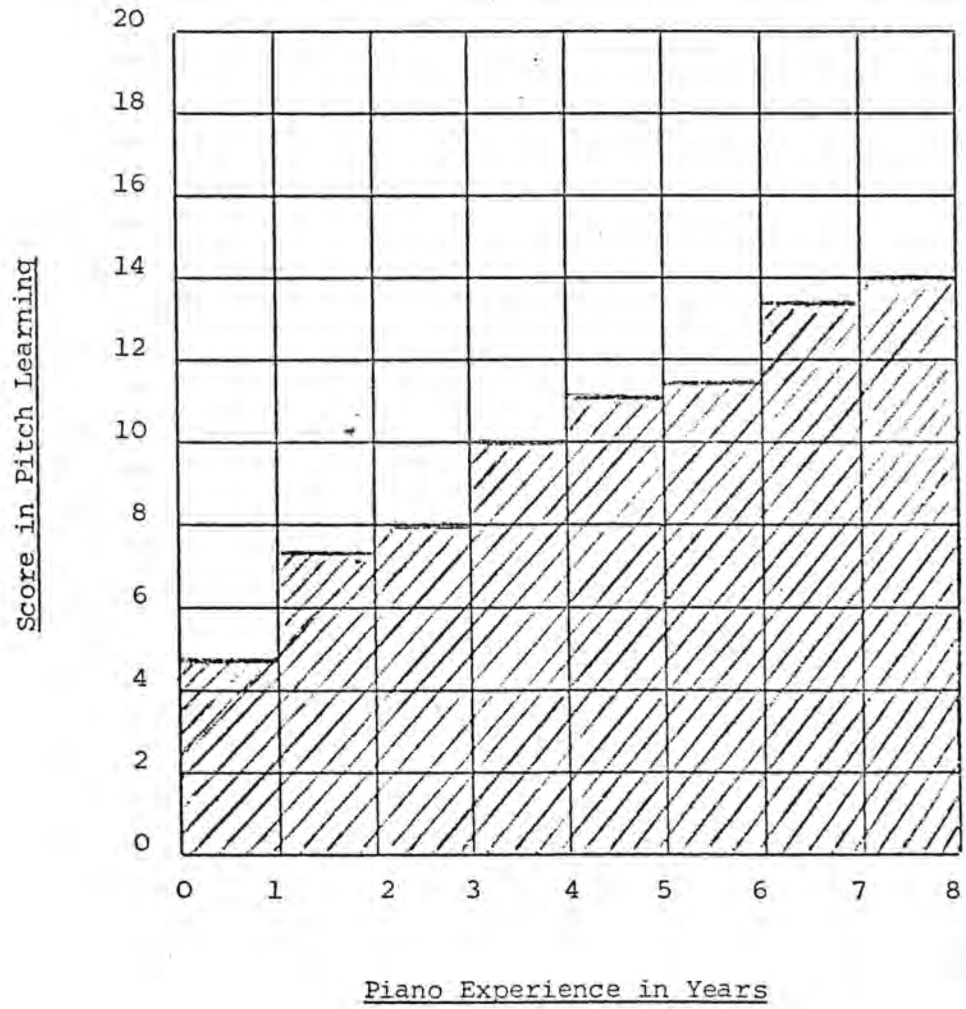
INSTRUMENTAL INFLUENCE ON PITCH LEARNING

An experiment was carried out with 300 girls between the ages of 11 and 14 years selected for education at a Direct Grant School. I.Qs. were assessed at 120 plus and all were audiologically screened from 125 Hz to 8 000 Hz, with the screener set at 20 dB. The 300 girls were submitted to the training programme as described previously, for one academic year. They all received three sessions of forty minutes a week. Melodic and Interval dictation tests were then given and the scores recorded. The scores were then listed under the appropriate headings once it was established which girls had received instrumental tuition prior to the training programme. The results were as follows:



It was noticed that the first learning of pitch by these post-nine year old children was better when samples were presented in the form of meaningful melody than presented when in intervals. This is in complete contrast to the learning shown by the pre-nine year olds in the Worthing experiment described in Section III.

Using the same group, I then analysed the results of the instrumental experience on Relative Pitch Learning as shown by Melodic Dictation and Interval Recognition. The previous graph showed that it was quite safe to use an average of both scores, by relating the individual scores gained to the length of instrumental experience on the piano. The following was the result:

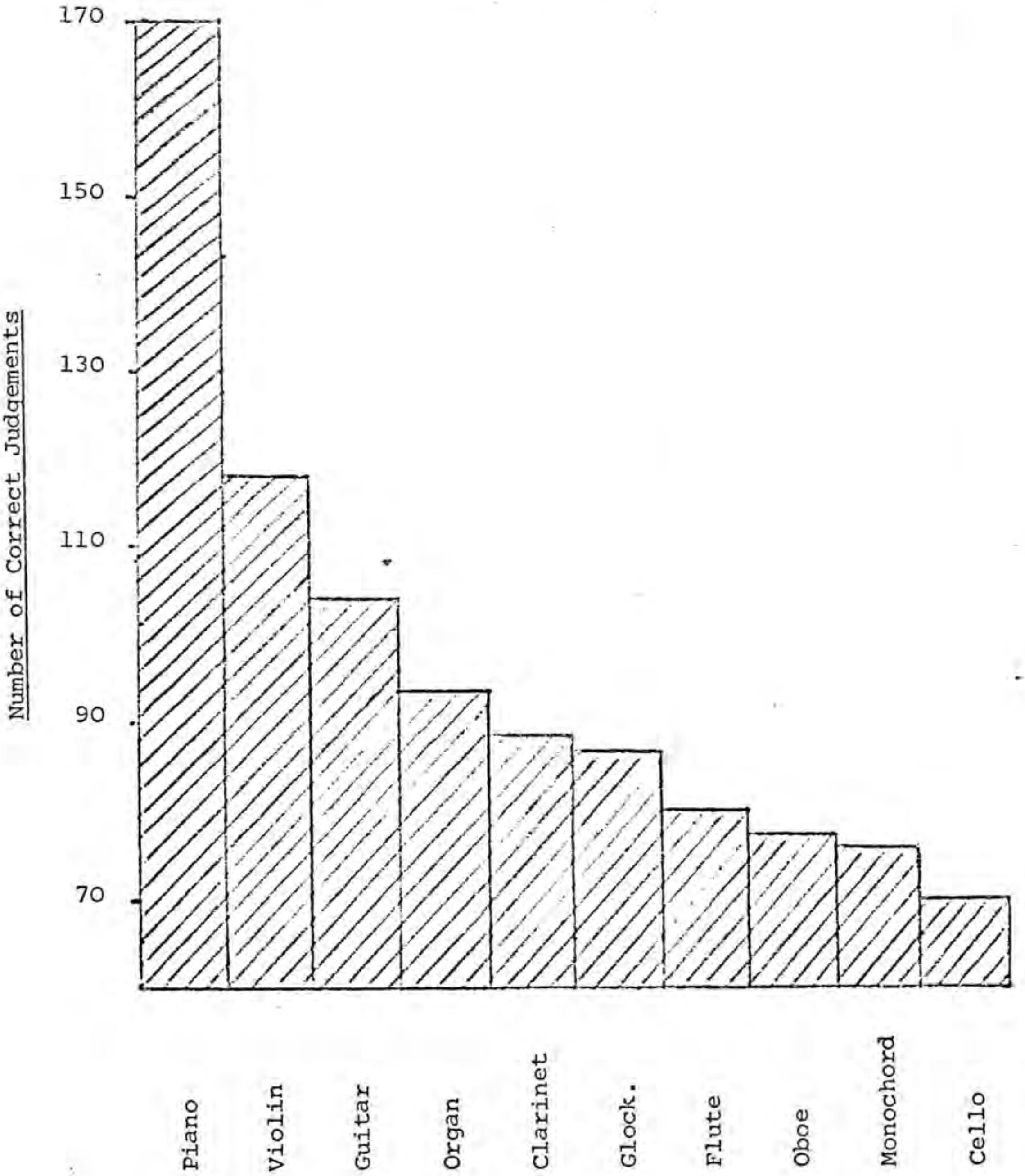


I then tested the effects of learning the Guitar, Recorder, Clarinet, Flute, French Horn, Violin and Cello for varying periods of up to eight years with smaller groups, but in these cases could find no pattern of increased learning of Relative Pitch according to the length of instrumental experience. See also section on Environment.

The need for a consistent pattern of pitch was very obvious in Hungary where standards of pitch varied according to teacher and the piano was not used as a point of reference. It was noticed that pitch learning was slower and less accurate without the use of the piano. In a comparison between two groups of children of similar ability, one where the piano was used and one where it was not, it was found that there was approximately two years difference in standard. Perhaps this is the underlying cause for the lack of pattern of increased pitch learning with instrumental experience, where instruments requiring constant tuning are used by young unskilled musicians, who unfortunately do not have regular access to a musician to tune their instruments for them during the early years.

Sergeant found that Absolute Pitch subjects scored more highly when the tests were given on the first instrument they had learnt on as a young child. He also found that the notes most easily learnt were those the most frequently used in early childhood; such is the importance of Auditory Memory and the quality of tone of the early instruments used by the child.

Proportions of Correct Judgements recorded by Group I (Absolute Pitch Subjects) for each Instrument used in the Pitch Denomination Test



<u>Timbre Perception</u> (musical instrument recognition) like all other aspects of pitch is learnt (Roederer, 1973). The first stage is tone source recognition, i.e.

(a) Storage in the memory with an adequate label of identification.

(b) Comparison with previously stored and identified information.

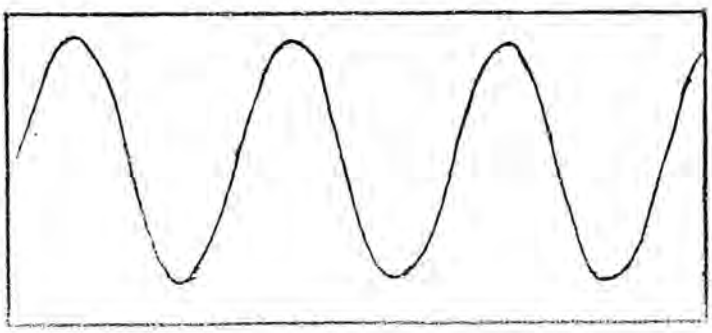
Accordingly the pitch learnt during the early optimum years will include in its learning the timbre of the early instrument. This would explain Sergeant's findings that A.P. subjects scored more highly when tested on their first instrument. It would also explain why some children who changed instruments, or learnt to play more than one contrasting instrument during the optimum years, lost their accuracy of Absolute Pitch that they had begun to show. Absolute Pitch learning appears to require a one to one basis for first learning in the same way as language, i.e. one sound exactly the same each time to one meaning, that is a conditioned response. A variation of this, whether it be timbre quality or exact frequency can prevent such learning, in the same way that the very young child in an environment exposing it to several languages at the same time, can fail to learn to speak. Once the first learning is established, enabling the child to gain control over its vocal and auditory apparatus by practice, the child can learn as many languages as his intelligence will permit, by relating all others to the first.

Quality of sound, i.e. the proportion with which the upper harmonics mix with each other, together with transient attack and decay characteristics, are equally important as can be demonstrated by listening to a magnetic tape being played in the reverse direction. The quality of the sound during the optimum years will be learnt along with all the other characteristics. Is this the explanation behind the rather poor vocal tone quality being produced by children following work with the tuned percussion instruments without access to a piano?

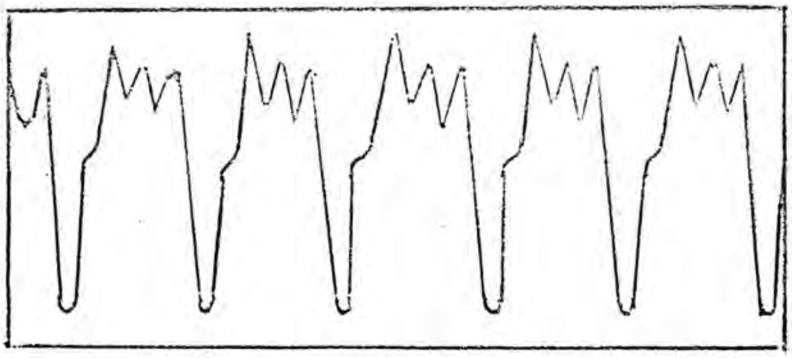
Routine Audiometry has shown how little attraction Pure Tones has for the young child. Experiments have also shown how the young child does not respond to any sounds which do not interest him. Research also shows that without a response to a sound being evoked the child does not learn the meaning of the sound. This being the case it is therefore important to study the complexity of tones of the various instruments, since it appears that the instrument giving the more complex tones is the one likely to attract the young child and consequently having a marked influence on Pitch Learning.

It is interesting to compare the wave form of the flute which shows as almost a Pure Tone with the results of my research showing the Flute, Recorder, etc., as not contributing to any learning of A.P. While comparing these, however, it is important to realise that few children learn to play woodwind instruments during the very early optimum years of pitch learning.

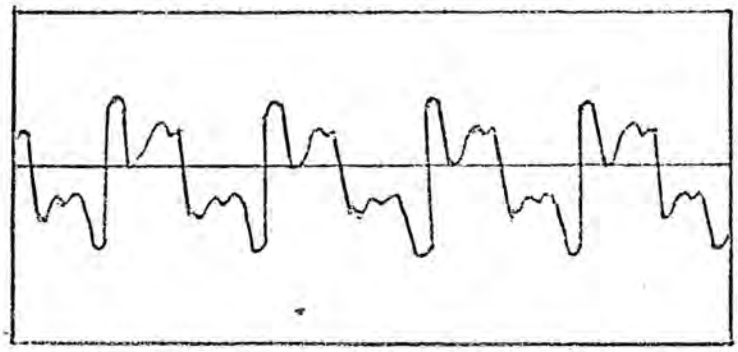
Wave Form of a Flute



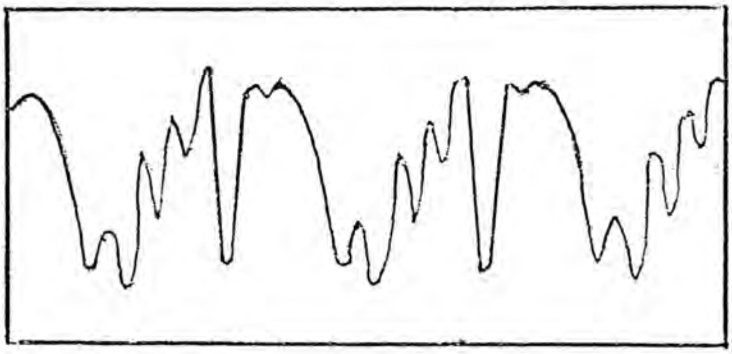
Wave Form of a Saxophone



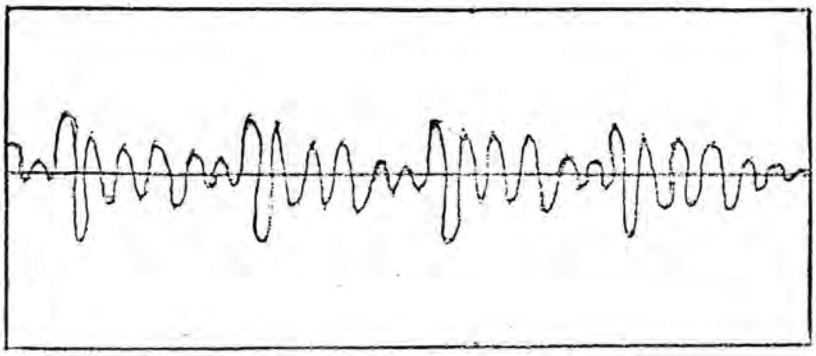
Wave Form of a Clarinet



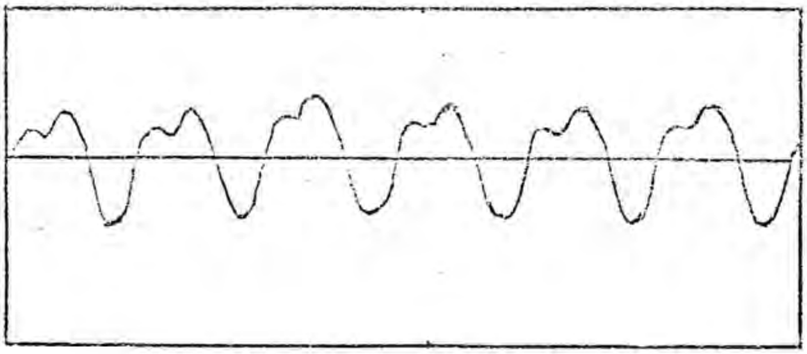
Wave Form of an Oboe



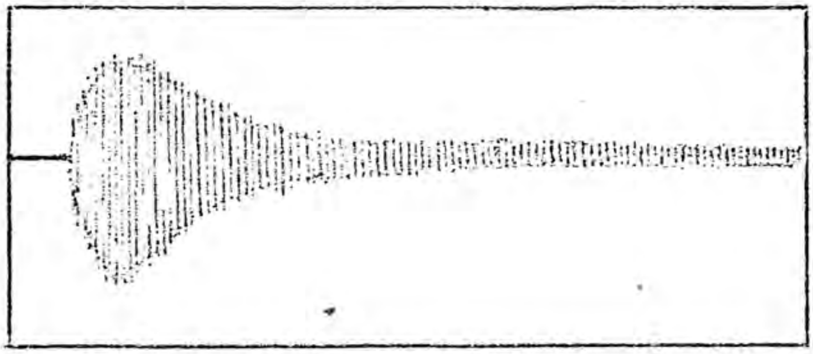
Wave Form of a French Horn



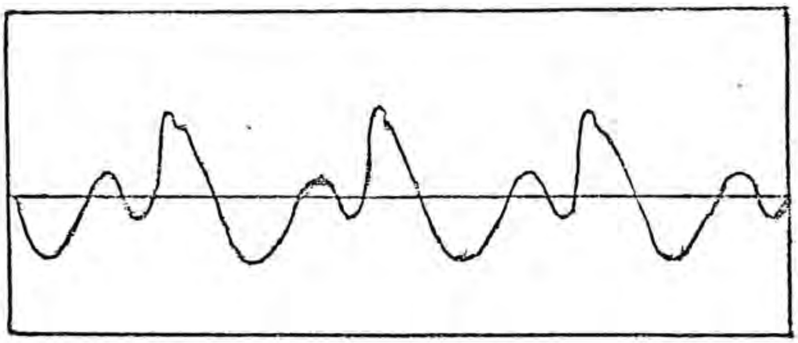
Wave Form of Violin



Wave Form of a Piano



Wave Form of Organ



When considering the complexity of the vibration patterns in relationship to potential pitch learning one must also realise that 'the smaller the interval between the component tones, the more difficult it is to perceive pitch.' E. Whetnell (1952) found that infants responded to a xylophone earlier than to a pure tone which they found too dull to be interesting.

Using the piano class as a means of instrumental experience for all and its effects on Pitch Learning

Initially the decision to teach all pupils the piano was based on two factors, i.e. that the school possessed three pianos and no other instruments, and secondly, that this instrument covered the pitch range required for musical education.

Procedure - All pupils were placed in classes of between twelve and fifteen children. At the first lesson all children drew a section of the keyboard to actual size, measuring the keyboard, studying its action and painting in the black notes. The desks were of the old fashioned kind, with a footbar at the back, and so at the next lesson this footbar became the pedal, and a good position at the instrument was established, together with hand and finger positions. Simple finger exercises to organise control were worked out in class and practised on the desk.

The Great Stave was worked out as described in the Training Programme, and simple games were introduced to attract attention to the difference in pitch. Once the stage in the Training Programme had been reached, where Staff Notation had been introduced the children found the notes on their keyboards with the finger, taking it in turn to come to the piano. As they found their notes so they sung them softly so that their singing coincided with their fingers, and became their instrument. Each piano class lesson therefore consisted of:

(a) Separate finger exercises, and checking of position at the keyboard - in this case their desk.

(b) Singing all notes as they played them - checking pitch at the real piano.

(c) Practise in reading of music.

Phrases of music were drawn on the board - a child would practice on the paper keyboard, singing it softly to himself. When he thought he knew it, he first had to sing it to tonic solfa and then play it at the real keyboard, without mistakes and with great attention to phrasing and fingering.

These lessons were held at first daily for ten minutes, then twice weekly for forty minutes. A practice rota was drawn up to enable every child to have twenty minutes practice daily. In this way, all children progressed rapidly and in order to assess the value of the progress, they were all entered for Grade V Associated Board Piano Examination, by the end of the second year. They were all successful and the idea was developed further by obtaining more pianos.

The next piano class was begun by having fifteen pianos, all tuned to each other, to enable each child to have its own instrument. The same method was used in every way, except the constant singing softly to provide the pitch when played as had been the case with the paper keyboards and the measuring up of the real keyboard to make the paper ones.

At the end of the second year this class also took Grade V. Technically the same results were achieved, but the standard of pitch learning was considerably lower.

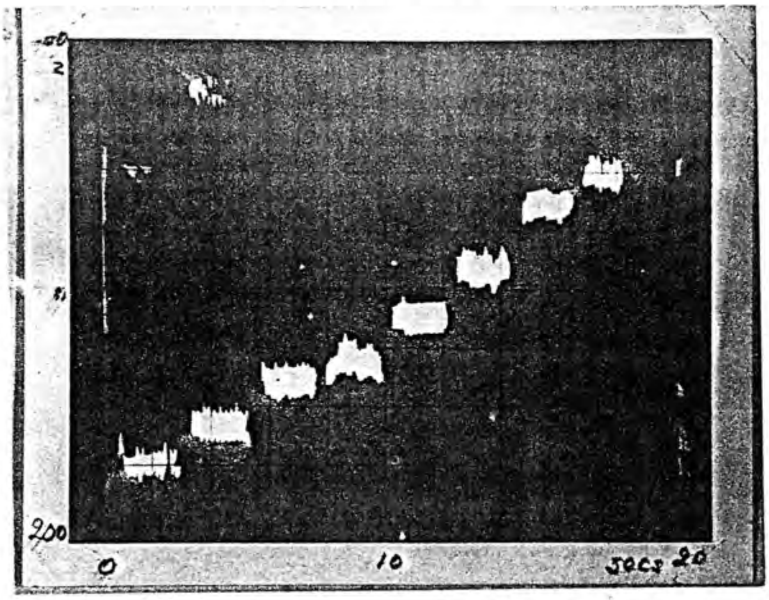
The Yamaha music school which has developed many of the above ideas still further likewise show considerable success in pitch learning.

The Relationship between Singing and Pitch Learning including a Study of so-called Tone Deafness

Tone Deafness - Many writers have shown that such a condition in the absence of clinical defect should not exist, since cases respond to training if it is provided at the right age. Nevertheless, in a survey of some thousands of children 6% were found to be described as Tone Deaf, albeit there appeared to be no clinical defects. The resultant improvement in singing in tune with a group of eight so-called 'Tone Deaf' students aged 18 years, when the reference tone was amplified suggests that, in spite of routine Audiometric Tests showing them to be of 'normal' hearing, they did in fact have some hearing loss. Perhaps the routine tests are not sufficiently sensitive for this purpose. I therefore set out to investigate this condition and for the purpose of the study, selected a group of 30 children in Hungary, 15 in the United Kingdom and 94 European children in South Africa - all of whom were described as Tone Deaf. Of the 15 children in the United Kingdom, I was able to investigate the incidence of Tone Deafness in their immediate environment and additionally, tape record their progress through the training programme already described.

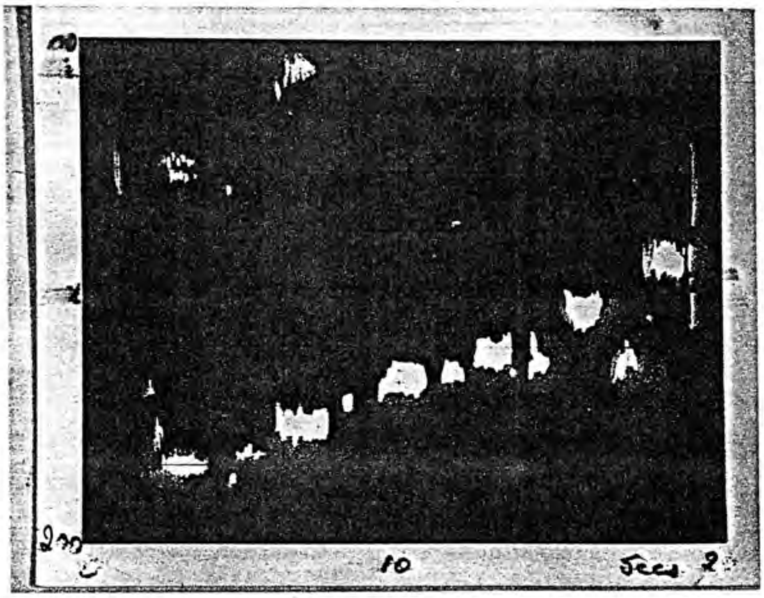
In a study of the inability to pitch a note in tune with the matching sample, photographs of Tape Recorded Samples were made on a Storage Scope prepared at the Acoustics Laboratory, Electrical Engineering Department of Cape Town University.

Photograph One



Tape Sample of one child singing in tune

Photograph Two



Tape Sample of two children singing one after the other, first the child singing in tune followed by the second child singing out of tune. As can be seen in photograph two, the analysis shows that the same frequency range exists in both samples, which rules out the possibility of a physical inability to vary the vocal cord length sufficiently. Of the 94 European children in South Africa with varying degrees of inability to sing in tune, the same point was established with all but one, who was later found to have a degree of spasticity. Measurement of the electrical energy at the larynx, together with tape recordings of the sound at the larynx also showed no defect.

The next stage was to measure the hearing levels of all the children. This was done by Pure Toné Audiometry, using an Amplivox Audiometer, model 51, frequency range 250 Hz to 8 000 Hz, from 10 dB to 100 dB, calibrated in accordance with I.S.O. standards, each child being first checked for pathological conditions of the ear. Routine pure tone Audiometry suggested that the term deafness was incorrect, as the bearing levels of this group were comparable to those who sang in tune. These two points being established and compared with the reports that so styled tone deafness responded to training, it would appear that this condition should be listed among those conditions of failure or retardation in learning during the optimum period.

In my opinion, this condition is the failure to establish an appropriate auditory vocal feedback system by sufficient experimentation and practice in varying the vocal cords to the auditory stimulus, in between the growth spurts of the vocal cords, to make it possible for the learning to take place.

Vocal Fold Development - A study of the Vocal Fold Development is self-explanatory:

14 days - 4 mm in length; 2 months - 5 mm in length;
9 months - 5,2 mm in length; one year - 5,5 mm in length;
5 years - 7,5 mm in length ; $6\frac{1}{2}$ years - 8 mm in length.

Then fairly static until puberty, when there is a sudden increase - 15 years - 9,5 mm.

This failure to learn could be caused by either insufficient training in learning to listen in order to be able to vary the vocal cords appropriately, or insufficient vocalising practice to obtain the Kinaesthetic experience of controlling the vocal cords remembering that this experience would vary following growth spurts. Occasionally a disturbance of normal growth spurts of the vocal cords makes matters difficult, since a stable behavioural field is a prerequisite for any learning. Another factor in tone deafness would appear to be the amount of hearing experience that took place during the optimum years, as some degree of first learning for pitch seems to be essential to assist in recognition of the sample to be matched. A lack of this first learning seems to occur in the very extreme cases of tone deafness. In these cases it was noticed that in addition to being unable to sing in tune even with an instrument, they were apparently unable to hear any difference between different pitches. This condition appears in two groups. Group A are those without physical defect but whose environment did not require them to discriminate pitch during the optimum early years, and Group B, where a physical defect, i.e. malfunctioning cochlea, existed during early years or currently exists making pitch discrimination difficult. Progress with this group was very slow, and required the maximum number of visual, spatial, tactual and kinaesthetic cues that it was possible to introduce. Nevertheless, progress did take place, thus proving that even this extreme type of tone deafness is a failure in learning.

The effect of Amplification and Duration on Singing in tune with older subjects - Two groups of students, Group A all from the Music Department of Rhodes University, and all capable of singing in tune, and Group B, unconnected with the Music Department and unable to sing in tune either accompanied or unaccompanied by an instrument.

Group B could not sing any interval but could manage with difficulty, scalewise passages from C to A when supported by instrumental accompaniment. All students were screened by routine Pure Tone Audiometry and found to be within normal limits. Both groups were then fitted with Madresco type Hearing Aids on a number 2 setting and their ability to (a) sing in tune, (b) discriminate between pitched sounds, was checked when the reference tone was amplified. Amplification appeared to affect the two groups

differently, and so further tests were carried out and the results recorded on page 190a. Two main points however emerged.

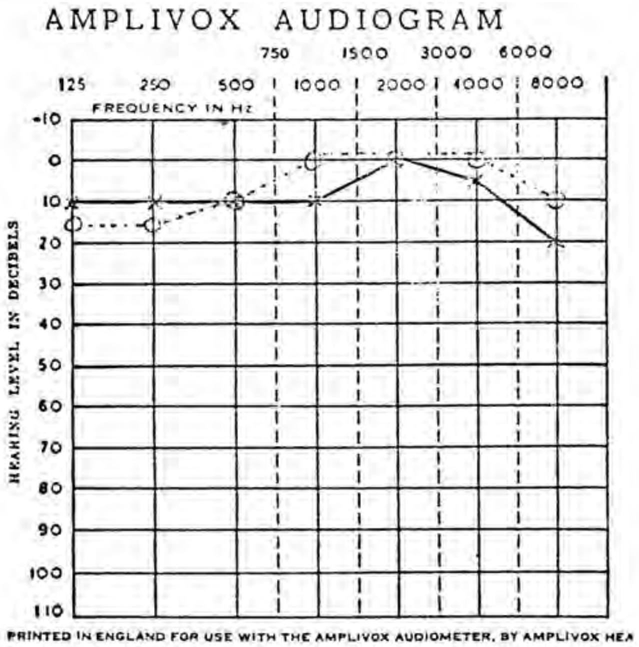
(a) The music students' ability to sing in tune became less reliable when the external stimulus was amplified. (See page 190a.)

(b) The so-called Tone Deaf group, Group B, improved in ability to sing intervals immediately, but there was little effect on scalewise passages (I have suggested earlier that this is not an auditory ability). The improvement continued steadily with each 5 dB increase of intensity until the stage was reached when further amplification produced unreliable intonation once again. A Linco Auditory Trainer was then used with an additional microphone to test the results of amplification of the students' own vocal response. This produced no change in the ability to sing in tune in either group. A stethoscope microphone was then used to test the results of amplifying the vocal response at the larynx but this made it impossible for the students to continue to sing. An Amplivox Auditory Trainer linked with a tape recorder, making it possible to control the duration of the sound stimulus, was then used to check the effects of duration on the students' ability to sing in tune. This did improve results and it was seen that the majority of Group B (eight) were able to match their voice when allowed sufficient time and vocal experimentation; the other two came fairly near to it, to the extent that it was felt that given sufficient length of time they would also be able to do this; duration is clearly involved.

The training of the so-called Tone Deaf group (Group B) continued with the use of Madresco type hearing aids in the hope that it would be possible to develop a pitch memory as well as enable the subjects to sing in tune.

At the end of ten months training the group could sing in tune but tests of Pitch Memory (Absolute Pitch) showed no change. Amplification therefore with this post-puberty group produced no Absolute Pitch learning at this stage. Earlier work however suggests that this procedure during the pre-puberty years would have also shown increased learning of Pitch.

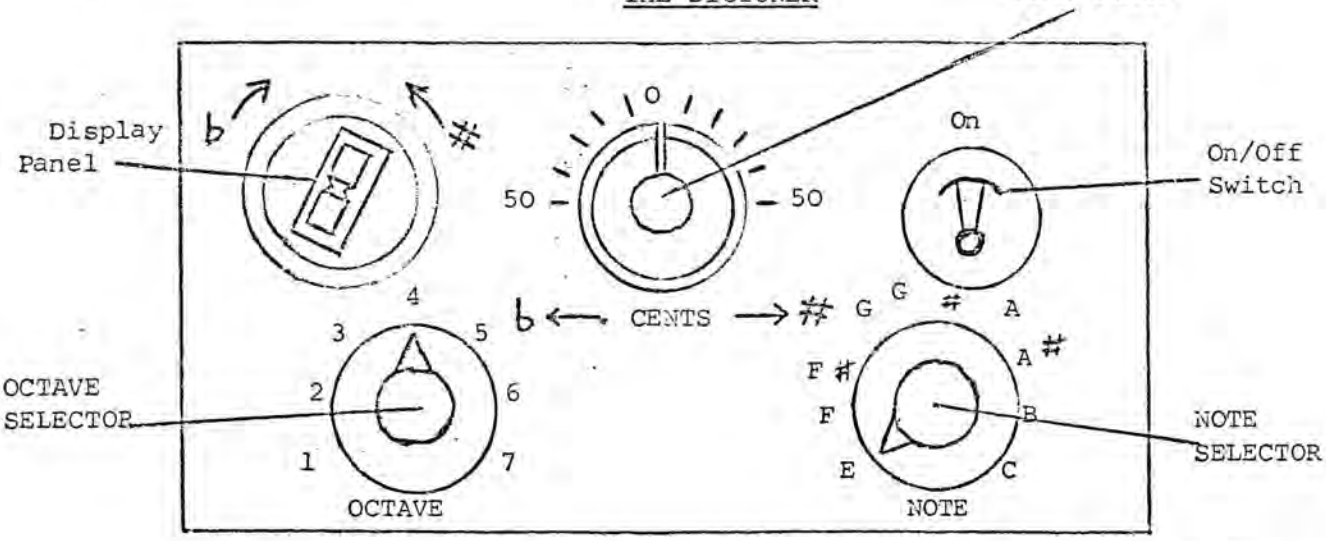
<u>The effects of Amplification on one Tone Deaf subject</u> - An eighteen year old tone deaf subject was checked by routine pure tone audiometry; the following audiogram shows that she had reasonably normal hearing for her age in both ears.



The Bentley pitch discrimination tests were carried out in order to check the function of the cochlea. She scored 14 out of a possible twenty, i.e. within the 'normal' limits. The subject was then connected to an Auditory Trainer and asked to sing the notes played on the piano within the diatonic scale from middle 'C'.

The intonation of the subject's response was checked by a pitchmeter (Diotuner). The piano notes were presented at the meatus via the Auditory Trainer, and the intensity levels were increased in steps of 5 dB. The Diotuner displays visually the accuracy of pitch, the amount of adjustment that may be needed and the direction of this adjustment. It is also very simple to operate. The Display Panel remains static if sample in tune, rotates clockwise when flat, and anti-clockwise when sharp, The speed of rotation proportional to mistuning - one rotation = error of approximately 4 cents.

THE DIOTUNER

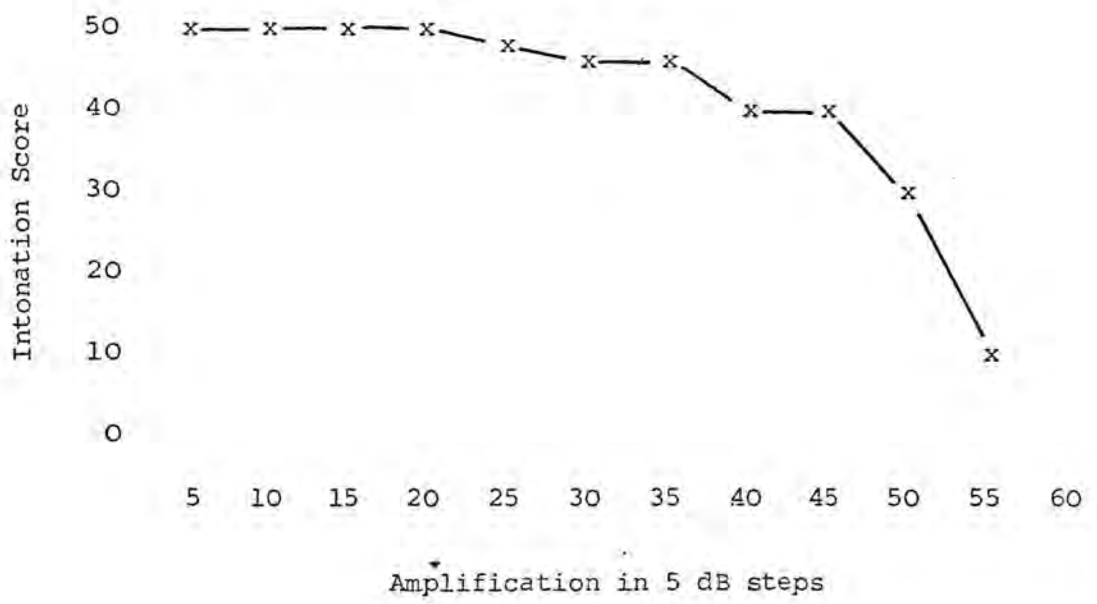


Each note was sung by the subject twice, once approached by step and once by interval. The results showed that she became more critically aware of exact intonation when proceeding by interval although stepwise work appeared easier. It was however quickly observed on the pitch display that the intonation was not exact in many of the notes approached by step. The note was sung by the subject who then adjusted her voice when necessary according to the visual display. Intensity levels were then increased in steps of 5 dB through the Linco Trainer. As the intensity increased so she improved in ability and speed in matching her voice to the piano. The best results were achieved at 35 dB and after this further amplification caused a deterioration in the results.

The same tests were then repeated with both Groups A and B, the resulted averaged, and the following graphs prepared:

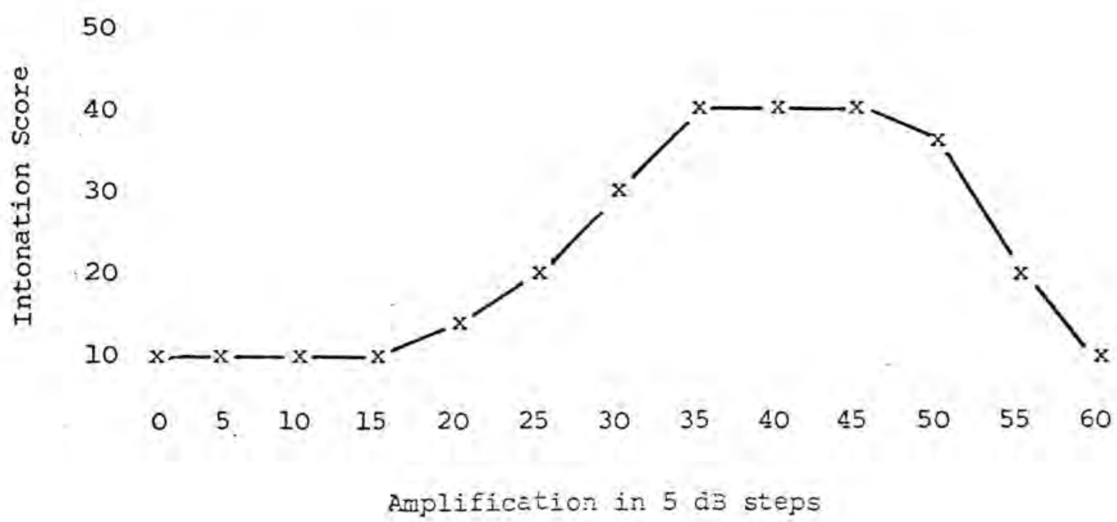
GROUP A

(Normal Hearing Music Students)



GROUP B

(Tone Deaf Subjects with Apparently Normal Hearing)



Some tests which were carried out at the Department of Otorhino-Laryngology, Ear Nose and Throat Hospital, Liverpool in 1971 by R.O. Jones and R. Pracy, appear to be in direct conflict with the finding that music students' ability to sing in tune became less reliable when the stimulating tone was increased in intensity.

Jones and Pracy found that tests carried out on hospital patients in order to test their ability to match pitch, showed that the error in pitch discrimination became less as the variable tone was increased in loudness. The intensity of the reference tone was set at 60 dB and the intensity of the variable tone was increased in steps of 5 dBs; results were recorded at each intensity increase.

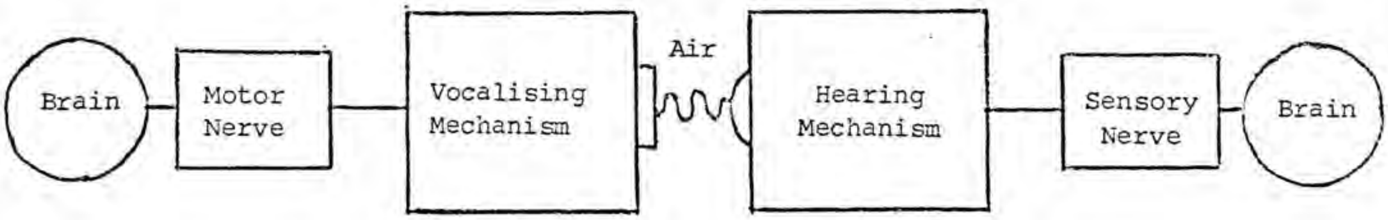
This may be explained by the fact that since they were patients at an E.N.T. hospital, they were suffering from some form of hearing defect. Their recorded results however, equate with those I obtained from the Tone Deaf group, that is Group B, who also showed improvement in pitch discrimination with each intensity increase until a 'ceiling' was reached, following which they showed a diminishing ability with further intensity increases.

VOCALISATION AND PITCH LEARNING

Physiology of Vocalisation - The voice is produced in the larynx, which is made up of two large cartilages. It fits on top of the wind pipe. The only thing we can do with the vocal cords is to alter the tension or length of them, separate them or put them together. The air from the lungs meets obstruction so builds up pressure - the vocal cords will withstand some pressure, but when sufficient pressure is felt they will part. This is similar to the breathing pattern, but is very much quicker as it rises to frequencies that the ear will recognise as sound. In order to show the nature of the sound from the larynx before it reaches the head, electrode plates were fitted at the side of the larynx and connected up to an oscilliscope, demonstrating the wave form. The larynx is described as the carrier wave of speech.

Tape recordings of the sound available from the larynx show that it is without resonance and therefore incapable of giving information. The pitch of a sound depends mainly on the fundamental frequency, accordingly when there is a variation in the rate at which pulses are produced by the vocal cords there will be a change in the pitch. When tension is increased the cords vibrate more rapidly and the pitch rises. This can be shown by lateral radiographs of the larynx. Speech is work (physical sense), therefore the source of energy is the air from the lungs. In breathing there is a regular pattern of in and out, but when we talk we use air only as going out and so the rhythm changes.

The Vocalising Chain



The connection between Singing in Tune and Pitch Learning - The importance of listening practice is stressed by A.N. Leontev, Department of Psychology, Moscow State University, when he says, 'if the conditions of an individual's life are such that they do not require him to distinguish sound complexes according to their basic frequencies, he may not develop a capacity for tonal hearing and remain tone deaf'. Bentley's pitch discrimination tests at the extreme edge of the vocal range showed 2½ times more errors than in the middle of the vocal range. Franklin and Vernon found that the more limited the vocal range the more limited the concept of tonality. Accuracy of judgement increased when notes fell within the vocal range with an 8,6% to 16,4% loss of accuracy when they were beyond the vocal range. Bentley found significant differences in pitch discrimination and tonal memory between monotones and adequate vocalisers, and Sergeant remarks that the expansion of a child's perception of pitch appears to advance side by side with expansion of vocal activities. A laboratory experiment conducted by some Russian psychologists to investigate Kohler's proposition that there is an intimate connection between stimulation of the auditory nerve and innervation of the organs used in vocalisation, began by studying the role of vocal motor activity in distinguishing the basic frequency of sounds. Intonation of a given pitch was measured, the subject being tested by the use of an oscillograph; subjects were then asked to intone the pitch of tones presented to them by singing them aloud. Every time the use of vocalisation was included, so the threshold of discrimination improved. These findings were later confirmed by several control and supplementary experiments.* With subjects who could not at first tune their voice correctly to a tone using a calibrating device, it was necessary to use up to six training sessions before they could do this. Once they were successful in doing this, their threshold of pitch discrimination improved. This showed that a subject had not only to tune his voice to the tone, but also to incorporate the procedure in the act of perceiving the pitch of a tone. We then tried to get

(*O'Connor, N., 1981.)

subjects to discriminate pitch without singing, at first by first fully attuning a subject's voice to the pitch of a tone and singing aloud; and then by asking them to delay the singing aloud until the tone had been cut off, i.e. asking them to soundlessly tune their vocal apparatus. An experiment in London consisting of measuring the mental energy at the vocal cord by the attachment of electrodes, also showed there was as much energy when the idea of the sound was interrupted and no vocalising took place, as when the vocalisation was allowed to be completed. (Mckelvie, Institute of Otology and Laryngology, 1971).

The process of the functions of vocal motor activity constitutes the key point in the development of tonal hearing, it is the act through which the ability to get a working notion of pitch is engendered. As Teplov also points out, this aptitude is always bound up with vocal motor activity and suggests that the intoning of sounds does not merely reproduce the sounds or tones perceived, but becomes part of the intimate internal mechanism involved in the very process of perception. With respect to musical pitch this activity performs the function of orientating a person so that he can discriminate pitch and make a comparative estimate of it - hence the beginning of Conservation and the valid suggestion that the onset of this may give some link with the vocal Fold Development of the child, permitting a vocal range of an octave, normally by about six years of age. That our voice sounds much louder to ourselves would also suggest that learning via vocal experience must be enhanced. However, recordings of the sound produced at the larynx showing it to be feeble and of poor quality, would suggest at this stage of the process, i.e. before the sound reached the resonating chambers, the act of vocalisation could not affect the learning of pitch. This would also suggest that the idea of pitch has been at least partially determined before vocalisation and must therefore be concerned with pitch memory. (Included under the heading of pitch memory is any activity which is not merely simultaneous matching of the voice with a given sample, but which involves recall of previously learnt matter.)

The experiencing therefore, of the sounds directed to the resonating chamber, contributes and reinforces pitch learning as this brings about hearing at the loudest possible level, since geographically, activation of the speech organs would be nearer to the brain than an external source of sound. This experiment in London therefore helps to confirm that the first learning of pitch must have already taken place to some degree, before monitored vocalising can take place and that in respect of development hearing is considerably in advance of vocalisation. From this it becomes apparent that the heart of any study of pitch acquisition must be concerned with pitch memory and its development. The relationship between singing in tune to pitch learning can be established in several ways. One is to show that to establish the Auditory Feedback system, information is required from the Auditory mechanism about the external sound stimulus and there must be sufficient reference sounds storage (pitch memory). The reference sound stimulus stored away in the brain must be re-called, and the vocal apparatus produce the sound to match the external stimulus, by varying the vocal fold length and directing the sound produced to the correct resonating chamber producing both the pitch and quality required. The consequential output must be monitored via the Auditory/vocal pathways to the brain throughout the activity and in this way the Feedback system is established. It can therefore be seen that before a Feedback system can be established it must be possible to use the output of the system to monitor the system, and that the activity of singing in tune is in fact the establishment of an Auditory/Vocal Feedback.

Secondly, one must study the various experiments showing the link between vocalising and pitch learning already mentioned.

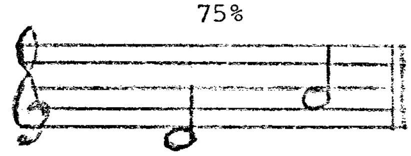
Thirdly, one can study the experiment using a Training Programme based on research into various methods and approaches carried out over a period of ten years in a Junior and Secondary School. The following investigation shows the importance of the sound stimuli being of sufficient level.

The Process of Phonation - The process of phonation begins with an increase in the electrical activity in the adductory muscles which reaches a maximum just before the onset of sound. From 0,35 to 0,55 of a second is needed to build up the value needed to produce the sound. An increase in the volume of the sound causes no change in electrical activity, but with the rise of pitch there is an increase in activity which indicates that the tension in the vocal cords is adjusted to a given pitch before the sound is actually produced. When the subject is asked to merely think about the production of a given pitched sound, without emitting the sound, the electrical activity increases.

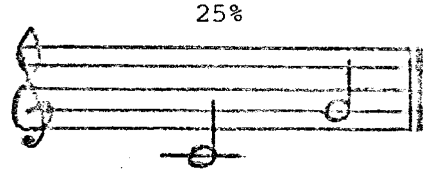
The Vocal Range of the Child - The vocal range of the child is not the same as the auditory perceptual range. For every sound vocalised we must be able to experience the full range of harmonics. This experience is normally through our hearing which establishes the auditory feedback. This explains the need for the high frequencies and the resultant distortion of sounds when these are missing. According to Sutzman (1907), the majority of children develop a vocal range of $1\frac{1}{2}$ octaves before puberty, with about 30% possessing approximately 2 octaves. According to Hell (1938) the infantile vocal range for singing develops thus:

Six years

75%

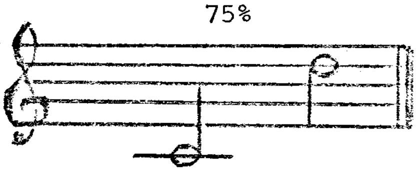


25%



Ten years

75%



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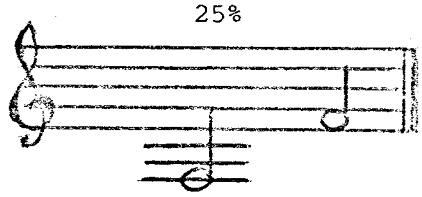


These limitations of the vocal range are supported by Jersild, Bienstock, Hartzell, Hathwick and Sherman. Imhofer (Zurich Medical School) has commented on the unusually narrow vocal range found among the sub-normal, implying that intelligence affects vocal range.

My work in a special school showed that intelligence affects pitch learning after puberty, but not before, and vocal range depended on vocal fold length and training with every indication that training affects the vocal fold length by:

(a) Stimulating growth.

(b) Gaining control in ability to vary vocal fold length.

This aspect could be affected by intelligence, since the learning involved in gaining the control necessary to vary the vocal folds length at will, requires ability in relating sensations.

I have found limited vocal range among tribes where their language had an exceptionally narrow range, but in the case of the very young children their experimental and exploratory vocalising covered the same range of others, which in my opinion illustrates that range at least is partially dependent on development by use. It is conceivable however, that since the experiencing of the higher harmonics relies on auditory perception, which in turn must be learnt, the perceptually handicapped child could find this an additional problem which may well result in a limited vocal range. Perhaps this partly explains the improved overall performance when sub-normal children are given hearing aids. A study of the vocal Fold Growth shows that the Vocal Folds are approximately 8mm at 6½ years, and then remain stationary until the sudden increase at puberty.

If this is compared with the increased vocal range between six and ten years of age it must surely confirm the effects of training on the development of vocal range. A study of the training programme used with children from the age of approximately four upwards, confirms the limitations of the vocal range according to Hell prior to training, with the exception that I have found only one child who started d^{o} to a^{o} and she gained c^{o} after eight months. The children with whom I worked, with this one exception, developed as described in the programme, that is:

From

At ten years with few exceptions, their range was:

It must be remembered however, that they received daily training, see Tape Recordings, and that the notes from:

were usually attacked by leaps both in training excercises and songs, but from:

were approached by downward singing and not by leaps, with great care to sing softly to avoid strain. This programme was carried out both with children measured as of limited intelligence, i.e. below 100, and those of high intelligence, above 120. The observed steady improvement of overall attainment, as the training programme was continued, was eventually expressed in examination results. The musical development was expressed in fluency in sight singing and the extent of vocal range. Further material for the study of vocal range and intelligence can be found among children abandoned at an early age in the bush and found living among animals. A limited vocal range was found among them all regardless of approximate estimates of intelligence (appropriate intelligence tests were not to be found). Their vocal range appeared to be that of the animal so, as far as I can trace, did their life span.

Preference for Falling Interval - It was noticed in the daily training programme, where work started in the drilling of listening and singing of scalewise passages and diatonic intervals, that although falling intervals were introduced much later than rising intervals, they quickly achieved the same standard, with considerably less practice. An explanation could be found in the effects that vocalisation has on pitch learning, as rising intervals are always more difficult to place correctly than falling. In the early stages of vocal technique learning, it is difficult not to drag up the lower register with the resulting poor strained quality and poor intonation,as a result of strain. To prevent this the early stages of vocal training should consist of practice on descending intervals only, until the correct placing is experienced sufficiently.

In routine Pure Tone Audiometry, I have also noticed that when checking each frequency at each Sound Pressure Level, there is a difference of approximately 10 dB according to whether the test sample level is approached from above or below. This was also recorded by researchers at the Nuffield Speech and Hearing Centre, London and many Audiometric technicians.

THE EFFECTS OF INTELLIGENCE ON PITCH LEARNING

Desmond Sergeant and Gillian Thatcher in their paper, 'Intelligence, Social Status and Musical Abilities', give details of the low correlation between general intellectual abilities and musical abilities, shown by many researchers such as Hollingworth, Cox, etc. They quote Cleak's observation that empirically there appears to be a dichotomy between experience in general classroom situations and experience in research. In my opinion, the apparent dichotomy disappears when one specifies the component skills of musical abilities, as however varied may be the list they will all include as important, both sensitivity of intonation and pitch memory.

The learning of pitch at the pre-puberty stage is not affected by intelligence and sensitivity of intonation can even be greater among the lower ability group because, as shown in the Suffolk experiment the threshold of boredom is reached much more slowly thus enabling meaningful pitch training to go on for a longer period. The work of Suzuki also suggests that much of what is described as musical feeling and interpretation is the result of auditory conditioning to establish interpretative patterns. Other aspects of musical ability make varying cognitive demands on the subject, but these could be assisted by the degree of sensitivity for intonation and absolute pitch that the subject has learnt. In my opinion this could explain the lack of correlation between 'intellectual variables and musical tests'.

Imhofer of the Zurich University Medical School, points out the 'unusually narrow vocal range' of the sub-normal child, but also remarks that 'musical receptivity is often better developed in the mentally retarded'. In a study of 30 children with I.Q. assessments of below 100 (Schonell Tests) at a residential special school, and compared with 30 children of I.Qs. over 120 of the same age range (8-9 years) in the junior department of a Direct Grant School, I found the following.

The lower ability group needed a far greater amount of drilling in the association of either notation or tonic solfa, with pitch than the higher group. The lower ability group received daily training in this association, five days a week for twenty minutes a day and took three weeks to reach the standard of notation recognition achieved by the higher ability group in two sessions of forty minutes. The higher ability group were able to respond more quickly to notation but showed less accurate intonation than the lower group. The lower ability group also showed greater accuracy of pitch memory, than the higher group when tested orally, but often made mistakes when translating the oral work into written work by the use of traditional notation. A greater exactness of pitch was shown by the lower group and better tone quality when singing. I believe this was due to the more exact copying of the sample given them. It is interesting to note in the results of some research which has been going on for nearly eight years, based in Suffolk, on the implications of Audio comparative language programmes and concept glyphs to the teaching of retarded and mentally sub-normal children with reference to certain aspects of language which requires constant repetition, possibly a minimum of thirty to forty times. This proved to be more acceptable to less intelligent children than intelligent, since the threshold of boredom was reached more slowly. It was noticed that the provision of hearing aids to a sub-normal group of children with no recorded hearing loss, improved all round performance. Pitch training produced the same results as did the Auditory Training given to the hearing handicapped in that it developed the ability to listen.

I then carried out an experiment in a school in order to attempt to measure the effects of auditory presentation and training. A piece of prose was selected for study by a group of twenty children of ten years plus, I.Q. range 90-100 (Schonell Tests A & B), who had received pitch training together as a class in daily sessions of twenty minutes, for six months. Ten children (Group A) went into one room and were given a sample of prose to study, in silence, for ten minutes. (Simple Prose Reading Test R.2. F.J.Schonell, 1962). They were not allowed to write anything down. The other ten children (Group B) were then each given a copy of the same test but were seated in listening booths, where tape recorded samples of the test were available. Each child wore headphones and listened to the recorded sample while following his/her printed copy of the test. This was repeated over and over again for ten minutes. Both groups were then given a question paper to test retention. The following scores resulted:-

After Pitch Training

Group A	46	51	52	55	56	56	59	55	57	63
Group B	62	90	86	83	84	91	86	87	93	98

Let the sample size of Group A be $m=10$

Let the sample size of Group B be $n=10$

Let the population mean score when material is presented visually be μ_2 and let the population mean score when material is presented audio/visually be μ_1.

We are to test Ho: $\mu_1 = \mu_2$ and Hi: $\mu_1 > \mu_2$

Let $\overline{X}_1$ be the sample mean of Group B and let $\overline{X}_2$ be the sample mean of Group A. Then $\overline{X}_1=86$ and $\overline{X}_2=55$.

Let $S_1^2 = 82,3992$ be the sample variance of Group B and $S_2^2 = 19,2002$ be the sample variance of group A.

I then tested to see whether there was any significant difference between the scores before and after pitch training both when the material was presented visually and aural-visually.

Group A

Before	45	47	47	48	48	49	50	53	55	58
After	46	51	52	55	56	56	59	55	57	63
Difference	1	4	5	7	8	7	9	2	2	5

To test whether there is any significant difference between the scores before and after pitch training.

i.e. test $Ho: \mu = 0$ against $Hi: \mu > 0$

Here $\overline{X} = 5$ and $S = 2,6077$

$$T = \frac{\sqrt{n-1}\;(\overline{X} - u)}{S}$$ has a $T\,(n-1)$ distribution.

If Ho is true then T observed $= \dfrac{\sqrt{9}\;(5-0)}{2,6077}$

$= 5,7522$

We reject Ho if T obs. $>$ T from tables with 9 df.

$T_{(9)}$ at 5% = 1,833; at $2\frac{1}{2}$% = 2,262; at 1% = 2,821; at $\frac{1}{2}$% = 3,250; at 0,1% = 4,30;

Therefore we reject Ho and accept that there is a significant difference at the 5%, 1%, $\frac{1}{2}$% and even 0,1% levels.

Group B

Before	61	65	66	65	66	67	68	71	73	78
After	62	90	86	83	84	91	86	87	93	98
Difference	1	25	20	18	18	24	18	16	20	20

To test $Ho: \mu = 0$ and $Hi: \mu > 0$

$\overline{X} = 18$ $\quad S = 6,2450$

T observed $= \dfrac{\sqrt{9}\,(18-0)}{6,2450}$ if Ho true.

$= 8,6469$

Since T observed $>$ T from tables we reject Ho and accept that there is a significant difference at the 5%, 1% and ½% level; i.e. (highly significant).

The daily sessions of pitch training were carried out in the following manner:-

(a) Sound proof cubles were available for individual use whenever required, complete with tape recorders and headphones.

(b) Tape recorded texts of all set works were provided in order that they could be presented, slightly amplified and at the meatus, by the use of headphones.

(c) Dramatised recordings of set works or topics were provided whenever possible.

(d) Five sets of 'B & H Language Master' equipment was provided for work requiring a great deal of audio/visual repetition.

In 1963 twelve of these youngsters took tke '0' level G.C.E. examination. The subjects covered were Geography, English Language, English Literature (syllabus B), Mathematics (syllabus B), German, Music and General Science. Those candidates taking Geography, English Language, the optional Spoken English examination, English Literature (syllabus B) and German, had all received extensive audio/visual training in the sound proof booths in addition to the usual class work. In each of these of subjects the passes obtained were between 85% and 100%. While it must be remembered that successes recorded in percentages with small groups can appear exaggerated, nevertheless a comparison with the 1963 '0' level G.C.E. results, G.C.E. Examination (Ordinary Level) Passes 1963 - Expressed as a %

	Comprehensive School (mixed ability)	Modern School IQ 85-100	Technical School IQ 112-120	Unrecognised Independent School(mixed ability). Often Unqualified Teachers	Grammar School IQ 120 plus
Geography	62,6	49,1	49,2	46,0	67,7
English Language	39,6	32,5	43,0	27,8	67,5
German	32,5	11,4	21,3	15,1	53,4
English Literature(B)	36,1	32,9	43,5	33,8	55,6
Music	61,5	40,0	44,4	21,1	67,0

These examination results were sufficiently dramatic to result in a major Local Education Authority instructing their Psychologist to re-assess the pupils for whom they were responsible as they appeared to contradict I.Q. assessments. The original I.Q. assessments however were found not to be in error.

If the ability to relate is correlated with intelligence, the results of a ten-year study of Pitch Learning would at first appear rather puzzling. In the study entitled 'The Age Factor', contained in Section III, it can be seen that pitch training given to youngsters at pre-puberty stage developed a good memory of pitch expressed in accurate sight singing on the establishment of the tonic, regardless of intelligence. It can be seen that those of lower intelligence showed greater exactness of intonation albeit they had needed more practice initially. They were however slightly slower in the identification of the visual cue, and therefore took slightly longer to recognise the degree of the scale represented by the notation, but once this was identified the intonation was excellent. This is considered to be explained in the section

I then carried out an experiment in a school in order to attempt to measure the effects of auditory presentation and training. A piece of prose was selected for study by a group of twenty children of ten years plus, I.Q. range 90-100 (Schonell Tests A & B), who had received pitch training together as a class in daily sessions of twenty minutes, for six months. Ten children (Group A) went into one room and were given a sample of prose to study, in silence, for ten minutes. (Simple Prose Reading Test R.2. F.J.Schonell, 1962). They were not allowed to write anything down. The other ten children (Group B) were then each given a copy of the same test but were seated in listening booths, where tape recorded samples of the test were available. Each child wore headphones and listened to the recorded sample while following his/her printed copy of the test. This was repeated over and over again for ten minutes. Both groups were then given a question paper to test retention. The following scores resulted:-

<u>After Pitch Training</u>

Group A	46	51	52	55	56	56	59	55	57	63
Group B	62	90	86	83	84	91	86	87	93	98

Let the sample size of Group A be $m=10$

Let the sample size of Group B be $n=10$

Let the population mean score when material is presented visually be μ_2 and let the population mean score when material is presented audio/visually be μ_1.

We are to test Ho: $\mu_1 = \mu_2$ and Hi: $\mu_1 > \mu_2$

Let $\overline{X}_1$ be the sample mean of Group B and let $\overline{X}_2$ be the sample mean of Group A. Then $\overline{X}_1=86$ and $\overline{X}_2=55$.

Let $S_1^2 = 82{,}3992$ be the sample variance of Group B and $S_2^2 = 19{,}[illegible]$ be the sample variance of group A.

The statistic $T = \dfrac{\left\{ (\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2) \right\} \sqrt{m + n - 2}}{\sqrt{\frac{m + n}{mn} (nS_1^2 + mS_2^2)}}$

has a T distribution with (m + n - 2) df.

If Ho is true then

$$T_{observed} = \frac{(86 - 55)\sqrt{18}}{\sqrt{\frac{200}{100}(82{,}3992 + 19{,}2002)}}$$

$$T \text{ obs.} = 9{,}2265$$

Therefore we reject Ho if T obs. $>$ the T value from the tables with 18 df.

T values with 18 df.	5%	1,734	$2\frac{1}{2}$%	2,101
	1%	2,552	$\frac{1}{2}$%	2,878

Since T obs. $>$ all these values we reject Ho: $\mu_1 = \mu_2$ and accept that $\mu_1 > \mu_2$ at the 5%, 1% and even $\frac{1}{2}$% level of significance.

These results were then compared with the scores achieved on similar tests by the same groups before pitch training, e.g.

Before Pitch Training

Group A	45	47	47	48	48	49	50	53	55	58
Group B	61	65	66	65	66	67	68	71	73	78

To test; Ho: $\mu_1 = \mu_2$ against Hi: $\mu_1 > \mu_2$

Here $\overline{X}_1 = 68$ $\quad\overline{X}_2 = 50$

$S_1^2 = 21{,}0002$ $\quad S_2^2 = 15{,}0001$

If Ho true then $T \text{ observed} = \dfrac{(68 - 50)\sqrt{18}}{\sqrt{\frac{200}{100}(21{,}0002 + 15{,}0001)}}$

Therefore T observed = 9,0000

Since T obs. $>$ all the T values then we reject Ho and accept that $\mu_1 > \mu_2$ at the 5%, 1% and $\frac{1}{2}$% level of significance. i.e. very strong significant difference between the mean score when using visual method and that when using audio/visual method both before and after pitch training.

Since T observed $>$ T from tables we reject Ho and accept that there is a significant difference at the 5%, 1% and ½% level; i.e. (highly significant).

The daily sessions of pitch training were carried out in the following manner:-

(a) Sound proof cubles were available for individual use whenever required, complete with tape recorders and headphones.

(b) Tape recorded texts of all set works were provided in order that they could be presented, slightly amplified and at the meatus, by the use of headphones.

(c) Dramatised recordings of set works or topics were provided whenever possible.

(d) Five sets of 'B & H Language Master' equipment was provided for work requiring a great deal of audio/visual repetition.

In 1963 twelve of these youngsters took the 'O' level G.C.E. examination. The subjects covered were Geography, English Language, English Literature (syllabus B), Mathematics (syllabus B), German, Music and General Science. Those candidates taking Geography, English Language, the optional Spoken English examination, English Literature (syllabus B) and German, had all received extensive audio/visual training in the sound proof booths in addition to the usual class work. In each of these of subjects the passes obtained were between 85% and 100%. While it must be remembered that successes recorded in percentages with small groups can appear exaggerated, nevertheless a comparison with the 1963 'O' level G.C.E. results, headed 'Intonation and Intelligence'.

At the post-puberty stage however, the degree of ability even to sing in tune with an instrument, is seen by the data given in Section III to vary according to intelligence. This I believe to be partly explained by the size of the auditory stimuli arriving at the cortex being considerably reduced by the post-puberty stage, - too small for first learning as is shown by the inability to learn pitch after puberty, albeit sufficient for mere reinforcement identification with non sound cues, i.e. visual, tactual, spatial, etc., or the relating to earlier pitch learning. This links up the Suffolk Experiment showing how the amplification of sound increases learning among the sub-normal. Its converse would, I believe, explain these results. At the post-puberty stage the maximum use would need to be made of visual and other cues to aid learning. The relating of these to the auditory cue would therefore be governed by the individual's ability to relate.

CREATIVITY IN MUSIC MAKING AND PITCH LEARNING

Having studied the many writings and followed the research into Creativity,* noting in particular the findings that the Highly Creative Group were often far more successful after school days than the Highly Intelligent Group, I accepted that any activity developing Creativity was an essential function. It must therefore be catered for in education with the possibility that the so styled Creative Arts would probably have to assume the responsibility for this. Albeit I really believe that the responsibility lies in the use of suitable teaching methods in all subjects, that will permit and encourage this development, since really the term

(*Vernon, P.E., 1972.)

'Creative Education' should be a tautology.

It was my interest in Education of the whole child to reach its maximum potential, that at first led me to a deeper study of the much abused term 'creativity', rather than my interests in Pitch Learning as at that stage I saw little connection. It was only as a result of study and an analysis of Creativity that the connection with pitch learning became apparent, and I realised that my dislike of 'gimmicks' was responsible for a lack of objectivity on my part, and that I was blindly condemning the worthwhile with the worthless. To rectify this I went off to a Centre of Music Creativity for a year to study the subject as broadly as possible, and prepared the following report.

Analysis of the Creativity Urge and its relevance for Pitch Learning

(1) What is Creativity? According to Rogers, creativity is a product growing out of the uniqueness of the individual and his reactions to material events, people and circumstances; but he adds that creativity must mean useful creative activities as otherwise it would be useless.

(2) How does creativity manifest itself behaviourally? A study of the writings of others produced the following Personality Traits:

(a) Not afraid of failure, making mistakes, taking risks or looking foolish.

(b) A positive outlook and a feeling of having something to give.

(c) Independent and undeterred by hardship.

(d) Originality - awareness of individuality - some loneliness.

(e) Open to experience - flexible.

(f) Self-confident, yet sensitive and self-critical.

(g) Strength of character.

(h) Persistence and dedication.

<u>What are the Environmental Factors found to aid the development of Creativity?</u>

(a) To be in a stimulating challenging environment.

(b) Time must be made available when ideas can come spontaneously and be developed without disturbance.

<u>What activities were found to develop creativity?</u>

(a) Writing fragments and ideas down as they occur, then thinking, divergently, to develop them.

(b) Constantly researching, exploring, experimenting and thinking divergently.

(c) Constantly receiving, verifying and preparing material and ideas, which stimulated a thirst to know and do more.

(d) Possessing a variety of interests and activities.

<u>What Abilities and Aptitudes are found in very creative people?</u>

(a) Superior intelligence.

(b) Versatility - all-round ability.

(c) The technical knowledge to develop ideas and 'join inspirations'.

(d) Imagination (in itself an exercise of memory) but a <u>productive</u> imagination, not merely a <u>reproductive</u> one.

(e) Ability to deal inventively, but rationally with material, with a fluency of ideas, bold thinking and re-definition.

(f) Observation using <u>all</u> the senses, insight and sensitivity.

(g) Ability to evaluate accurately and quickly, attributes and problems, together with a breadth of vision.

(h) Ability to work hard for long hours.

(i) Ability to think divergently instead of only convergently.

Observations for the consideration of those responsible for Educational Programmes

(a) The guidance of creative people is made more difficult by their versatility, as few have achieved great eminence in one field without displaying more than average ability in many fields.

(b) Because a creative person is a many-faceted creature his needs are only served through practices honouring his uniqueness.

(c) The environment must offer a challenge to the creative person - mere material benefits are of no advantage, often a disadvantage.

(d) Conventional training is antipathetic to the diverger - says Hudson, and therefore jeopardises the nation's supply of creative talent. Training should therefore become more progressive, without removing the aspect of challenge.

(e) Research projects indicate (i) that creative productivity can be developed by deliberate procedure, (ii) that creative activity, like most behaviour, includes many learned skills.

(f) Medicine has moved from opinion based on hunches to judgements based on controlled experiments - now the Education world must do the same in the study of the acquisition of basic component skills.

(g) In a recent research project, it was found that a group of highly creative people scored considerably higher in attainment assessments than a group of highly intelligent people.

Reaching a criterion for the identification of Music Creativity

As Rogers has pointed out, creativity must have a purpose and so therefore must eventually involve not only exploration of the materials used, but gradually the organisation of the materials and their use into some recognised form and/or shape. Much that goes by the name of Music Creativity is concerned only with the exposition and exploration of the possible materials available and goes no further, as it is not concerned with the idea of effective communication and therefore remains merely self-satisfying. I have been very puzzled by the inflexibility of many so styled Music Creative experts.

Saturation point is reached varying only in time according to the individual potential, and boredom quickly follows. The greater the potential of the child, the more quickly is the threshold of boredom reached with the attendant danger of frustration. Without interactionary communication necessary for stimulation and the constant evoking of response necessary for all learning that is of the senses, self satisfying activities can only lead to intoxication and its attendant emotional imbalance when indulged in to excess. The victims become inward-looking, self-seeking and withdrawn to the point of autism. If one examines the basic components of creativity it will quickly be seen that such activities are therefore incorrectly labelled as Creative. I would suggest therefore that any criterion for the identification of Music Creativity should include:

(a) The process must communicate.

(b) The process must include the eventual identification, recording and preservation of the creation.

(c) The process must involve organisation and control.

This second criterion ensures that the exercises have an identifiable purpose and result in creation. It is most easily effected through the means of notation, which in itself leads to more definition, providing the notation used is supplemented by invented cues for any effect wanted and yet not covered by traditional notation. To use a notation of pitch accurately means initial conditioning of the auditory/visual cues. To explore sound effects and invent means of notating them involves much experimenting and critical listening - as is shown by the work of John Paynter and Brian Dennis. The more critical the listening, the more the learning that will take place, and so it follows that the more Music Creativity measuring up to the criteria mentioned that takes place during the optimum period for pitch learning, the greater the pitch learning. Clearly however, there is a need in the early stages for the development of the notation skills and the creative urge to take place, side by side, until the stage when a successful marriage can take place, in the same way that reading and writing techniques are acquired alongside creative writing activities. While it is true that care must be taken not to so swamp the child with the work of others that the creative urge is crushed (Peters, 1967) the inability to express oneself in words or gain inspiration from the words of others through reading hampers creative development, so also the inability to notate musical sounds and effects or reproduce the works of others hampers the development of real Music Creativity.

As the Schools Council Research and Development Project on Music Education of Young Children found, free experimentation with instruments and sounds without guidance can lead to 'nothing more valuable than a vague notion that we can produce different sorts of sounds from different materials'. In my own observations of various Creative Music Projects I have been very concerned at the lack of follow-up work. Surely it is dangerous to arouse emotional interests and excitement without providing an outlet suitable to the ability, age and aptitude of those so aroused.

For as Anthony Storr remarks, 'insistence upon self control can of course be overdone, resulting in the loss of access to emotional spontaneity altogether but without the capacity to control and inhibit immediate responses, human intelligence could not have developed'. He goes on to say, 'we are apt to be sentimental about the so-called creativity of the nursery school child, forgetting that spontaneity has to be combined with order and control if true creativity is to be achieved. The effect of learning to inhibit or repress immediate responses to emotional stimuli is the acquisition of flexibility. If all your responses are reflex you will remain both rigid and limited'.

One aspect of Creativity in Music which appears to be sadly ignored, is the need of the individual to create something it can 'have to hold', an end product which is not intangible and ephemeral. This is particularly true of the young child in the early stages of achieving music literacy. The making of simple pitched instruments can fulfil this need and in so doing contribute towards pitch learning. Xylophones and Bamboo Pipes can be made from local materials and can be tuned, note by note, by the children.

A pitchmeter such as the 'Diotuner' with its visual display of pitch is best used, but failing this a piano may be used. The need to listen and reproduce the exact pitch to match the sample is excellent training in listening, which with sufficient practice would become pitch learning.

I would further suggest that the terms 'Music Creativity' and 'Musical Ability' be explored and researched, as in my opinion there is much to suggest that it is a person with general creative ability, whose early environment and audiological functioning made the acquisition of musical skills possible, that displays what is often called 'Musical Ability'. The late Professor Grossman, Director of the Vienna Boys Choir School was exploring the development of the creative urge via art in special sessions before admitting the boys to the Choir School in order to assess this aspect. The initial findings would seem to support the view that general creative ability must be developed in order to achieve musical creative development, while the main responsibility of Music Creativity is to study in isolation the "processes and procedures" of Music Creating (Cady, H.L., 1976).

HEALTH FACTORS IN ACQUIRING PITCH MEMORY

To isolate health factors only related to Pitch Learning is not easy and even if possible can only be of academic value since these factors affect learning generally. It is perhaps a study of vitamin deficiency that has relevance to a study of pitch learning as these are the deficiencies which attack the individual senses. This however, needs separate research and I can only list some observations made as a result of work on pitch training lasting sixteen years in a variety of environments.

Ten years' observation of 100 youngsters sent to a residential school as deprived and maladjusted often with additional physical problems produced the following points.

(a) Interest in the individual overcame the rejection suffered with its consequent dejection. As the dejection disappeared the child gained in weight, energy, interest and enthusiasm. Appetite and physical co-ordination improved and growth was accelerated. Concentration gradually became possible.

(b) Once the child became used to having sufficient food anxiety and tension decreased, but other factors, found to affect tension were:

   i) Lack of space for making a mess, building dens, etc., making a noise and literally running wild.

   ii) Insistence of being too clean and well dressed at all times.

   iii) Not having a cubby-hole for own possessions which were personal, and did not have to conform to standards of tidiness.

   iv) Not having the training programme explained to them so that they knew the point of activities and reasons for their difficulties.

<u>Visual and Auditory Acuity</u> : An increase in impact of auditory and visual cues affected overall level of attainment in the average and below average children to a very significant level. Greater enhancement was achieved by planned simultaneous audio/visual presentation of material with the use of headphones, and experiments with specially prepared glasses and hearing aids, based on optical and audiometric records of the child, achieved greater learning.

Experiments were conducted, based on trial and error, which suggested that:

(a) Multi-vitamins improved both physical and mental energy, attitude, concentration and appetite. (Injections of Parentrovite were used with the group under observation.)

(b) Vitamin C (3 x 50mg.) from October to March banished nasal colds and catarrh, but did not affect throat or chest infections. (The number of defective auditory memories found among the group of children who had suffered many such nasal infections during the first six years of life must make this relevant.)

(c) Vitamin A and D in capsule form from October to February cut down the respiratory infections. Respiratory infections depress pitch judgement by as much as a semitone. (Lancet, 1972).

Maternal nutritional deficiencies have accounted for some cases of sporadic congenital deafness. (Whetnall & Fry, 1964.)

Medical reports showing the effects of Physical Exercise : This developed an appetite in the children of the residential school which in turn supported the physical growth and supplied oxygen to the brain. Attention to fresh air intake in bedrooms and classrooms added to this and a first morning out of doors activity, regardless of weather:

(a) increased the alertness of the child by speeding up the metabolic rate.

(b) increased the acuity of hearing and speed of recognition, but time was required for relaxing as the intonation tended to be a little sharp at first. This tendency was also noticed in cold weather. Lack of oxygen as in a 'stuffy' room or very hot weather tended to cause the other extreme, i.e. 'flatness'. This would support the findings of greater sensory acuity in the infant when oxygen is used during child birth, plus of course the results of oxygen starvation to the brain.

Rest : Pitch learning as most other forms of learning appeared to need a period of rest during which 'fixing' became consolidated. Simple experiments during the training programme varying the number of days a week that training was carried out, showed at first that there was no difference in progress in pitch learning if five days a week training was carried out instead of seven. Further testing showed that by missing the training on Saturday and Sunday the progress on Monday seemed to be slightly enhanced by:

(a) earlier work appearing to be more established.

(b) new work tackled more energetically and learnt more quickly.

On investigating further, progress was retarded if the training sessions dropped to below four a week for the over ten year olds, and below five a week for the under ten year olds.

SEX DIFFERENTIAL

A greater percentage of monotones among boys is reported in the Education for Teaching Journal, Spring 1972, and a superiority of girls in singing has been reported by Seashore, Drake, Wing, Gordon, Bentley and Petzold. In an experiment of my own in a residential school for boys, I found that whereas this is usually the case it is through lack of early auditory and vocalisation training for the boys. The variation of possible hormonal influence between the sexes mentioned elsewhere and the very [illegible] time that the boy has the vocal cords of the right length to cope with the vocal experiencing of the higher frequencies. The ear has acoustical properties which allows the subject to hear a greater range than his vocalising range, but these acoustical properties are based on the harmonics of the vocalised fundamental (Ohms Law of Acoustics) - the nearer the harmonic to the fundamental the greater its intensity, thus the greater the potential discrimination and therefore learning. If the boy does not get sufficient training in establishing the required auditory feedback during the few years between the sudden growth spurt of his vocal cords at puberty, it will mean that his vocal experience will largely be of a lower frequency thus depriving him of the greater pitch learning that arises from vocal experience for the upper frequencies. The upper harmonics in the high frequencies are further from the fundamental, and consequently weaker, and will possibly be too weak for first learning by the post-puberty boy to take place. (The work of D.O. Hebb shows just how slow <u>first</u> learning is.)

In the case of the girl there is not the enormous growth spurt of the larynx at puberty, and so the continuation of training can proceed in the same manner as before and as a result time is on her side. Since monotones, in the absence of clinical defect, always respond to training providing it is before the tremendous growth spurt of the larynx on the part of the boys, the answer to the report by the Education Journal would appear to be that the problem is often caused by a shortage of time for first learning for the boys, and not any greater superiority on the part of the girls. The following bears out this observation.

For ten years in a boarding school with an age range of six to eighteen years, of which I was the headmistress, all boys received daily ear and voice training in the morning and at first a selected group only, attended choir practice in the evening. In a class of thirty regardless of age they all received piano class lessons; and those over eleven years of age began a second instrument of their own choice. All the children came to the school via Juvenile Courts and Child Guidance Clinics - many being excluded from entrance to ordinary schools; some were described as ineducable, few could read on entry. In all, a hundred children of both sexes were involved.

The pattern that emerged was that all children who were admitted to this school before the onset of puberty learnt to sing in tune, sight sing fluently, and achieve a pleasant singing tone. The greater the length of time that the child received the training before puberty the higher the standard achieved, until the position was reached when owing to demand children could only be admitted at the younger age level. The data in Section III illustrates this.

The result was that all the children then proceeded to the Choir as there was no need for selection. This choir then started to compete in Festivals - at first locally, then nationally, and finally internationally, with great success. The original motive in entering festivals had been to give these young life-rejects a chance to gain attention and praise in a socially acceptable manner, which needed effort on their part and a development of self-discipline. This certainly proved successful as each round of applause seemed to remove a little more maladjustment and a tremendous standard of self-discipline and hard work developed.

Gradually a very high standard of singing and musicianship developed and they entered the Concert Arena. Following a visit to the Vienna Boys School Choir with whom they sang some English folk songs, their motivation to do likewise became such that in 1965 they went on a concert tour in Austria for five weeks. They gave fifty-four performances, including television and radio programmes for which they received quite good fees - their success was measured by a request to sing some eight part early English songs sponsored by the British Council for a special television programme lasting thirty minutes. The British Council arranged air mail despatch for the music from England to Vienna; it arrived at 10 a.m. and soon afterwards these so-called ' ineducables ' started rehearsals; the only instruments available for our use was a piano for one hour and a tuning fork. Such was their standard of sight singing and musicianship that at 6.30 p.m. the same evening they went on the air and performed faultlessly from memory. There were 32 children of this age group and their success was such that the President of Austria gave them an official reception.

Although all children received daily training I found no success with those entering the school at puberty - confusion was at first caused by separating them according to age to judge results, but this disappeared when maturation was the deciding point. These findings were confirmed by a study of the individual medical records, as all children were fully examined every three months. The failure of the older entrants to respond to this auditory and vocal training was not lack of interest, because the success and enjoyment of the younger ones created great desires on the part of the older ones to share in their success, and it was from this desire that all the older children formed a Military Band (financed initially by the earnings of the choir). At the closure of the school the band was beginning to enjoy success with similar results in the behaviour standards.

It was noted however, that this instrumental work failed to achieve the degree of pitch learning that the younger children had achieved in their vocal training, in spite of the fact that just as much time was spent on this as the younger children had spent on their vocal training. (See Sections III and IV for the relevant data.) It was further noted that whereas the younger ones achieved both the ability to sing in tune and the ability to sight sing in tune without the support of a musical instrument thus involving memory of pitch, the older starters achieved only the ability to sing in tune when supported by an instrument and for the first time intelligence appeared to be a factor. The ability to learn to match their voice with a given instrument when learning after the onset of puberty definitely varied according to intelligence, yet in the case of the youngsters this did not happen. It was also noted that the tone quality of the boy, given the early training, was considered by the majority of people to be richer, stronger and generally more pleasant than the girl.

To summarise therefore, it will be seen that given the right training at the right time both boys and girls can learn pitch.* The boys' ability to learn Absolute Pitch appears to gradually decrease from approximately 7 years until vanishing altogether at puberty, whereas the girls show little gradual decline until puberty, but appear to lose their Absolute Pitch learning ability at puberty. With girls this appears to happen abruptly at puberty. The decline of pitch learning would therefore appear to match the rise of testosterona.

(*See section on Age Factor.)

Is this the reason why the sexually immature boy appears to be able to learn pitch while the mature boy of similar age does not?

POSSIBLE HORMONE INVOLVEMENT IN PITCH LEARNING

Bachem tested ninety people, selected more than three decades, all claiming to have Absolute Pitch. Of these, seven could not be faulted, and were perfect to better than a semitone, others were almost as good (J. Acoust. Soc. Am., 1937, p. 146). Some follow-up work has been done on the seven who could not be faulted, and certain changes have been noted:

(a) With the passage of time, three have drifted up a semitone, but when asked to sing A consistently sang Bb.

(b) Women who were tested showed that pitch varied in a biphasic fashion within the menstrual cycle.

Since Hawkins' discovery that absence of adrenocortical function sharpens both taste and smell (The Lancet, 4th March 1972), it should be no surprise that hormonal changes may influence the operation of the special senses. There have been reports that during the menopause women have lost their Absolute Pitch. Leontiv (1961) noted that pitch was depressed in women during pregnancy.

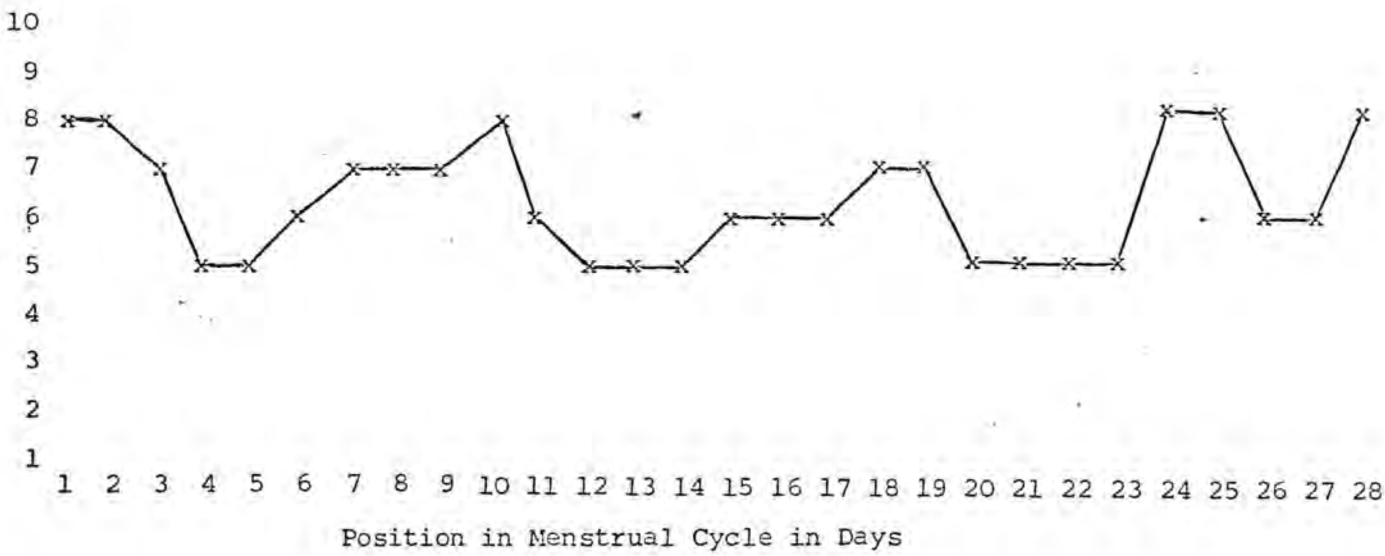
Additionally, Robert Henkin of the National Heart Institute found that not only was sensory detection at its lowest level when adreno-cortical secretion was at its highest level and vice versa, but when sensory detection was at an extraordinarily high level of sensitivity there was a difficulty in evaluating properties, i.e. making comparisons between loudness and tonal qualities. This was reflected in a difficulty in understanding speech. It was also found that even in normal subjects the sensory detection level varied according to the daily cycle (Levine, S., 1971).

David de Wiet of the University of Utrecht's Institute of Pharmacology, and Elemer Endruezi of the Institute of Physiology, University of Pecs, Hungary, found that as the startle response to sounds faded (the process they described as habituation but described by Pavlov as orientation) there was a rise in the level of adrenal-steroid hormones. All startle response fades with the repetition of the sound. When rats were deprived of the adrenal gland with the resultant high level of ACTH, a longer time was taken to habituate the sound (Levine, S., 1971). Would this be a means of artificially extending the period of pitch learning in humans? Alternatively, would prolonged exposure to sounds of the same pitch, duration and timbre, reverse the functioning of the adrenal gland? A few studies on animals have suggested that sound exposure may stimulate pituitary gonadotrophin release (Audiogenic Stimulation of Urinary Gonadotrophin Output in Man - Department of Physiology and Medical Biochemistry, University of Cape Town).

In the training of boys at a school of 100 pupils, age range 7 + to 18 +, in the south of England, I found they often showed a peak of enrichened tonal quality to their singing voice for a few months prior to the changing of the voice. This observation was repeatedly made throughout a period of ten years.

In order to further explore the possibility of hormone involvement in pitch perception, a pilot study for one month was carried out on ten female students aged between 16 and 18 years. Each student kept a careful record of their menstrual cycle and throughout the month attended a daily pitch training session of twenty minutes, starting each day at 1400 hours. Their Pitch Memory was tested by giving each ten notes to be named by individual sound alone, accurate to within a semitone, and without reference to any other note previously sounded. Their scores were recorded daily against their position in the cycle, i.e. the onset of menstrual flow recorded as M1, the next day M2 and so on, and the final results averaged.

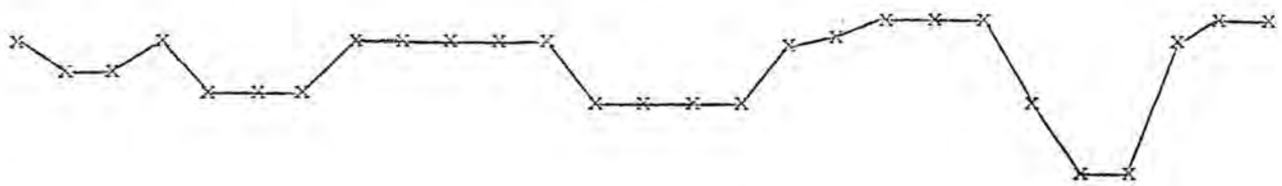
Pitch Memory



Having tested their Pitch Memory, I then tested the subjects' Pitch Discrimination by using Bentley type tests on a Frequency Generator. The scores for each subject were entered against their position in the cycle and the final chart was again prepared by averaging the results. (See next page.)

Variation in Pitch Discrimination of 10 Musically Experienced

Girls aged 16 and 18 years

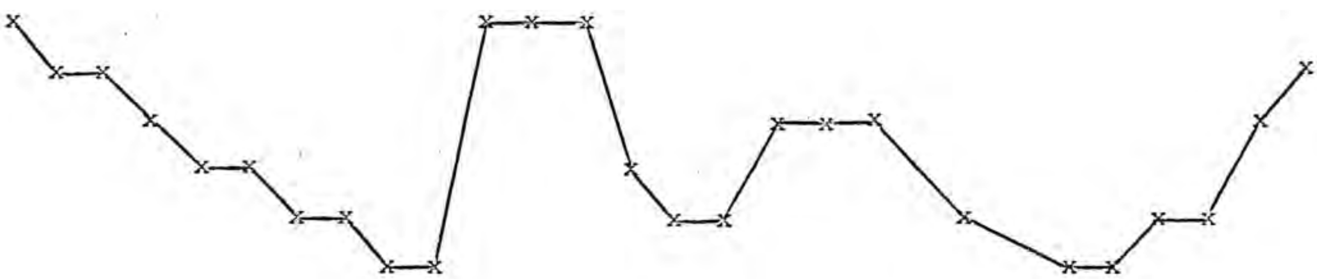


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

Position in Menstrual Cycle in Days

As Teplov claims, it is the speed in which the judgement of pitch is made that is the real criterion for determining the presence of Absolute Pitch, i.e. from 0.4 to 0.7 seconds for A.P. subjects, but from 2.5 to 24.0 seconds for non-A.P. subjects. I then recorded reaction speeds throughout the cycle.

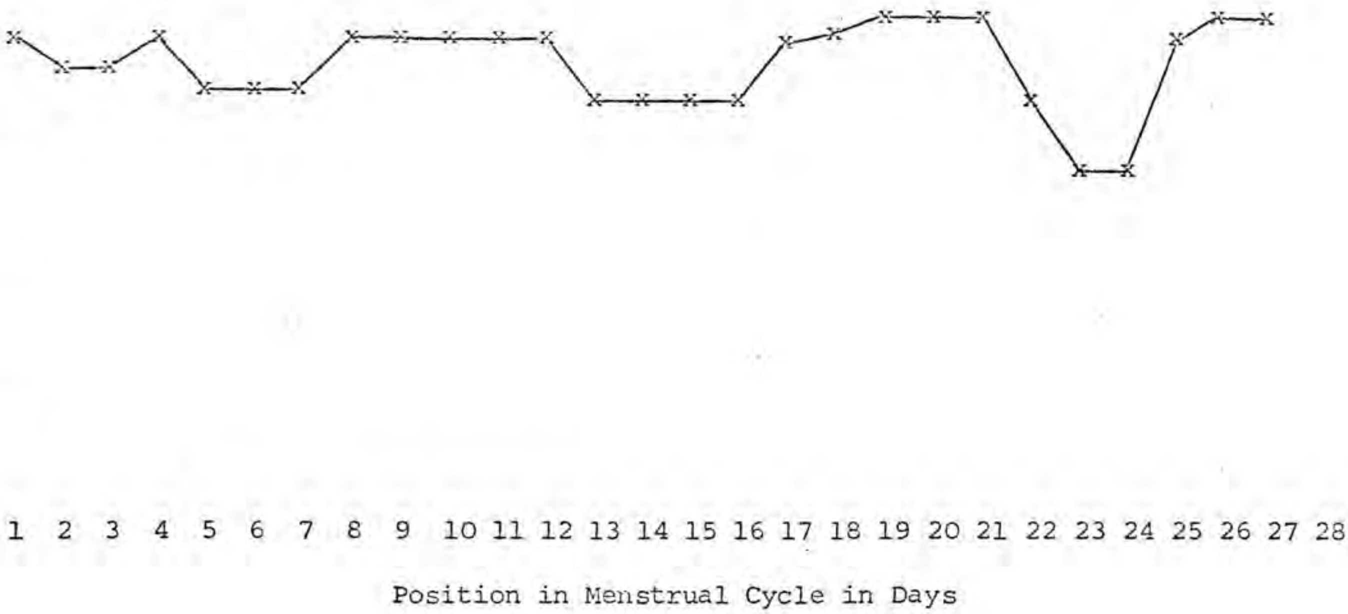
Reaction Time (Middle C)



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

Position in Menstrual Cycle in Days

Variation in Pitch Discrimination of 10 Musically Experienced Girls aged 16 and 18 years



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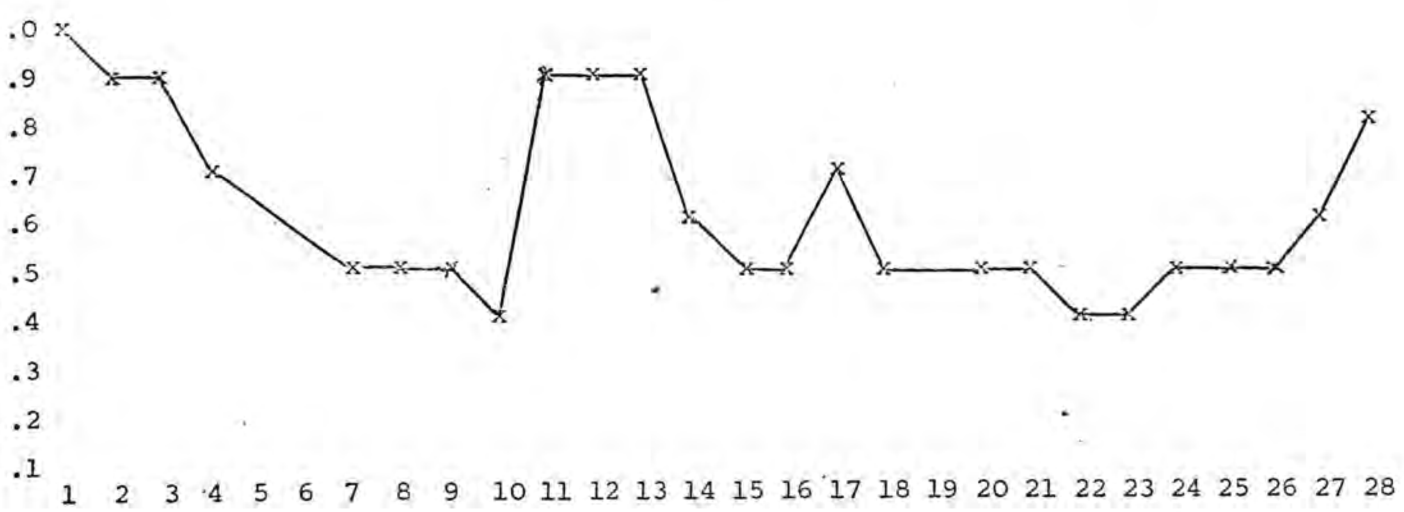
Reaction Time (Middle C)

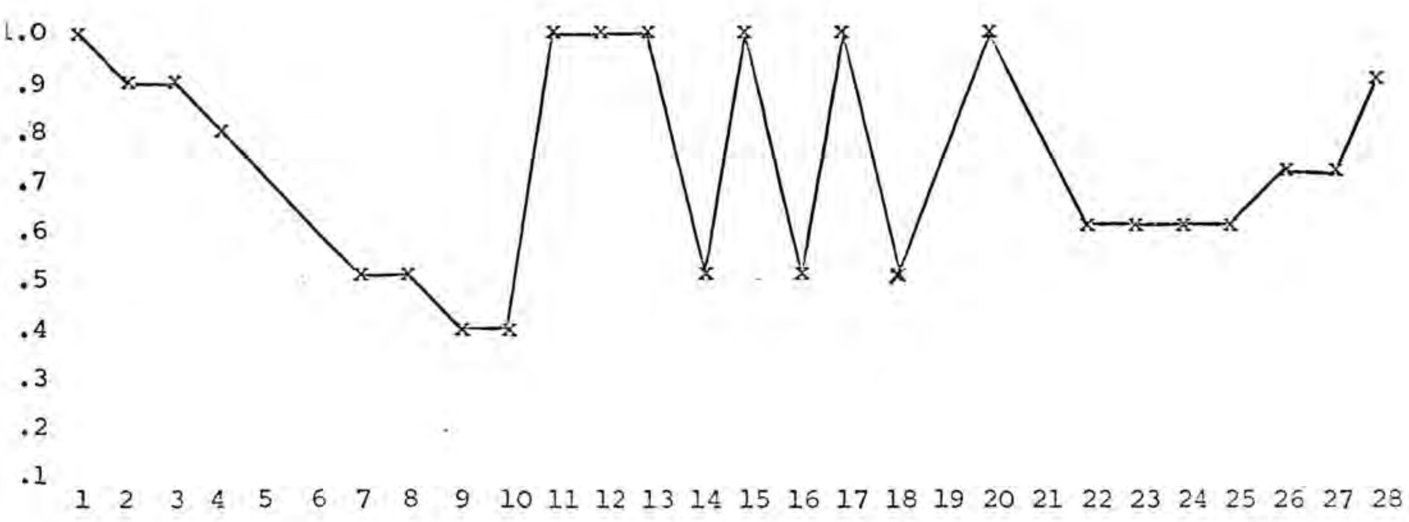
These averaged results appeared to be in accordance with those of A.V. Wynn in his study of 'Absolute Pitch in Humans', but as I noticed that reaction time varied according to pitch I repeated the tests for each note of the diatonic scale from Middle C.

Reaction Times for each degree of the scale by the same subject

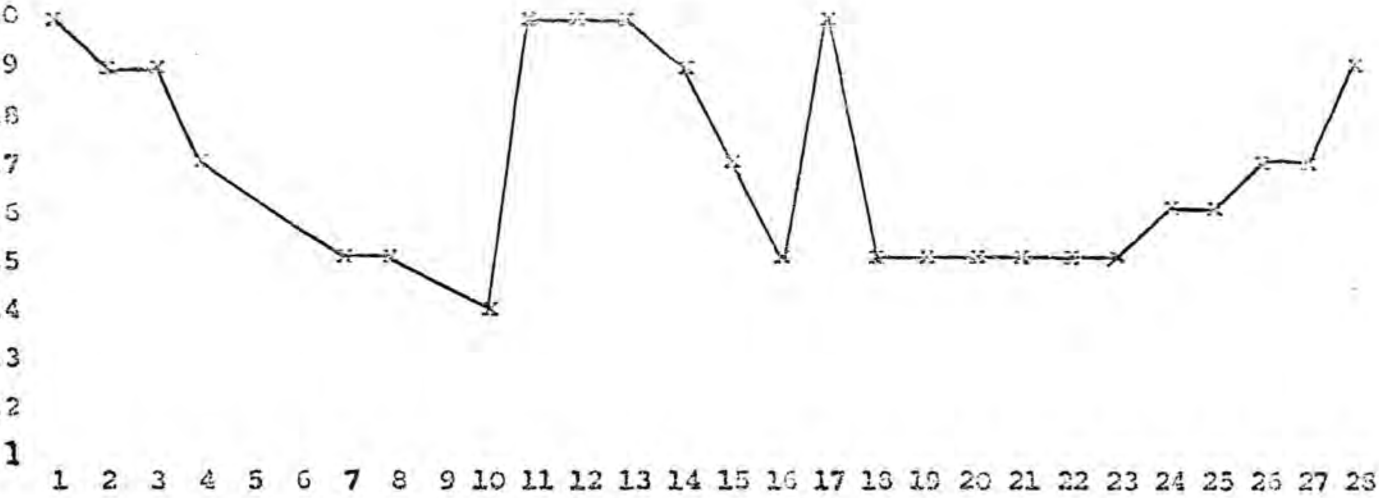
C^1



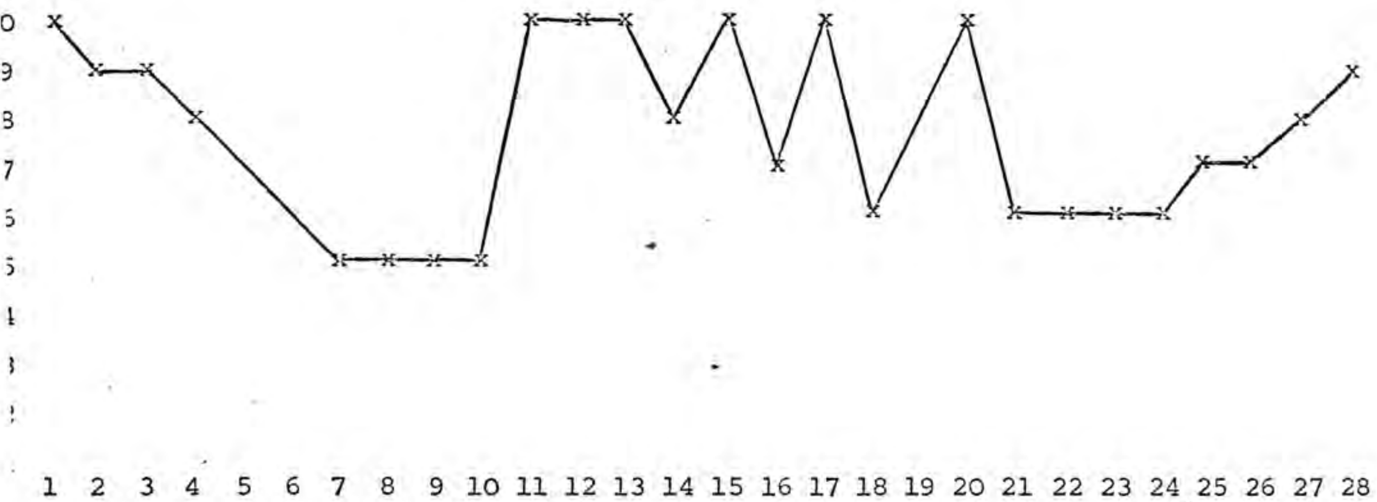
'D'



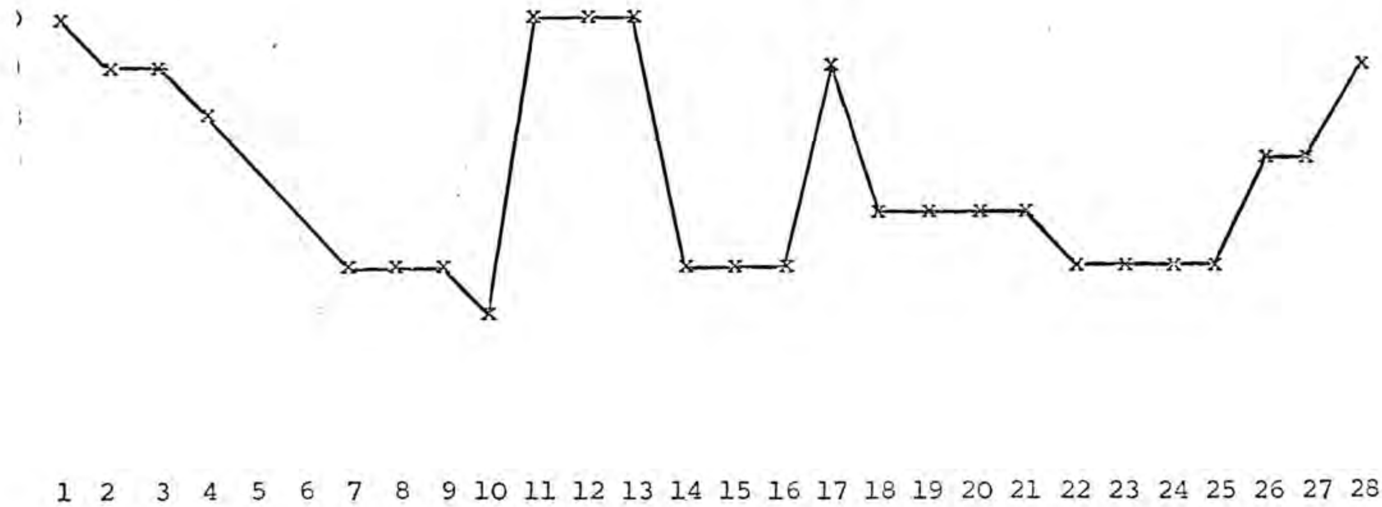
'E'


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

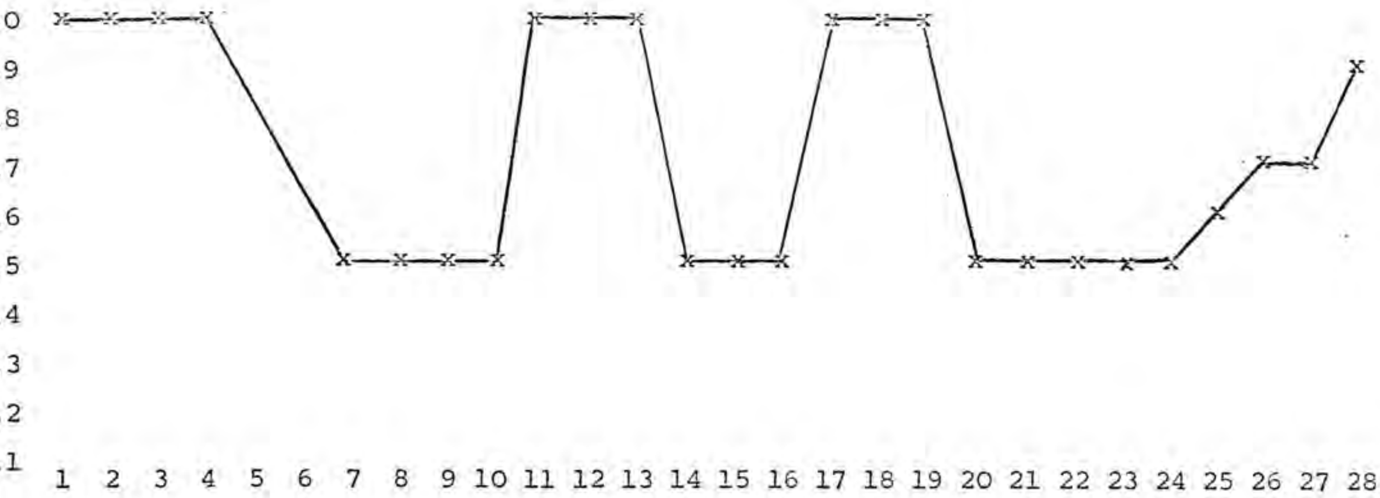
'F'


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

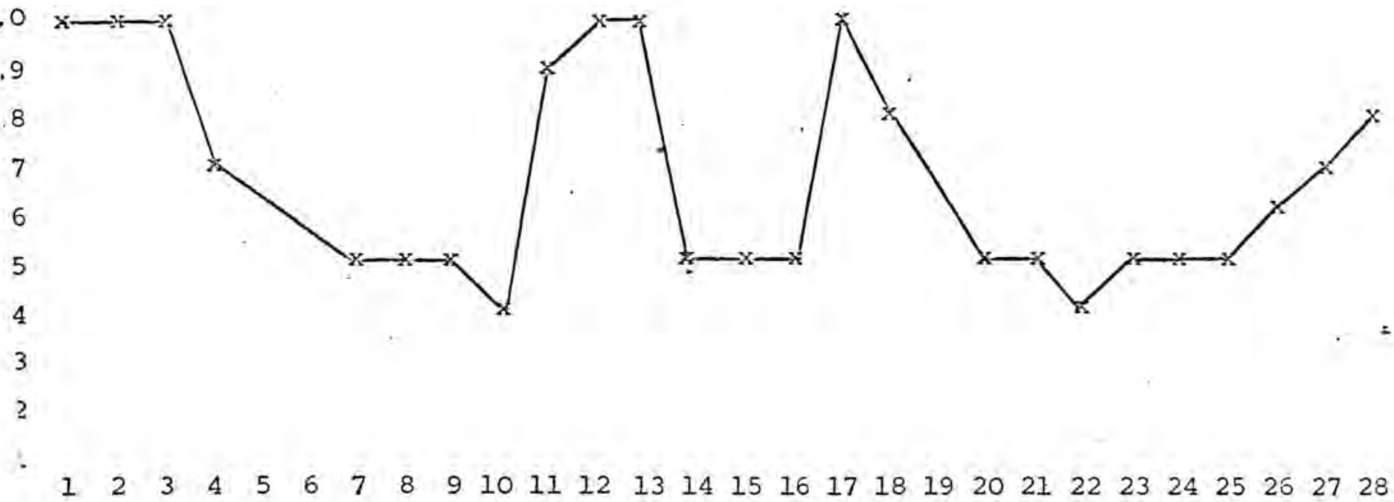
'G'


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

'A'



'B'



The variation of Reaction Time according to pitch appears to occur mid-cycle and is most noticeable among those degrees of the scale that took the longest to learn, e.g. F, D, A, B, etc. This, plus the fact that audiograms prepared daily at the same time as the Reaction Tests did not show a matching variation of hearing levels, would suggest that it is the pitch <u>memory</u> that is affected by the hormone levels. The basic pattern in the above graphs appear to match the pituitary function. It must however be remembered that reaction time generally varies with the menstrual cycle.

One must also remember that the method must satisfy the performer and yet be within his capacities and be flexible in approach.

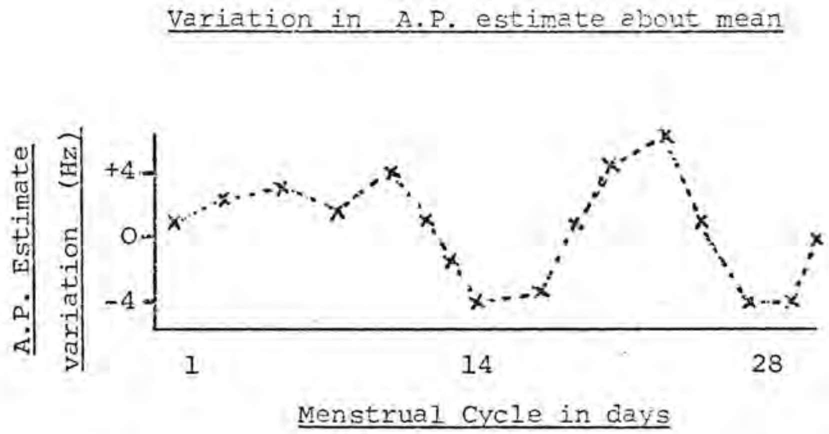
A STUDY OF THE TONIC SOLFA SYSTEM

Guido D'Arezzo, born in Paris about the end of the tenth century, devised a system which we now call the movable doh, when he took a Latin hymn written some four centuries earlier in which he noticed that each line began a note higher, and so he took the first word of each line, i.e. Ut, Re, Mi, Fa, Sol, Lah, etc.

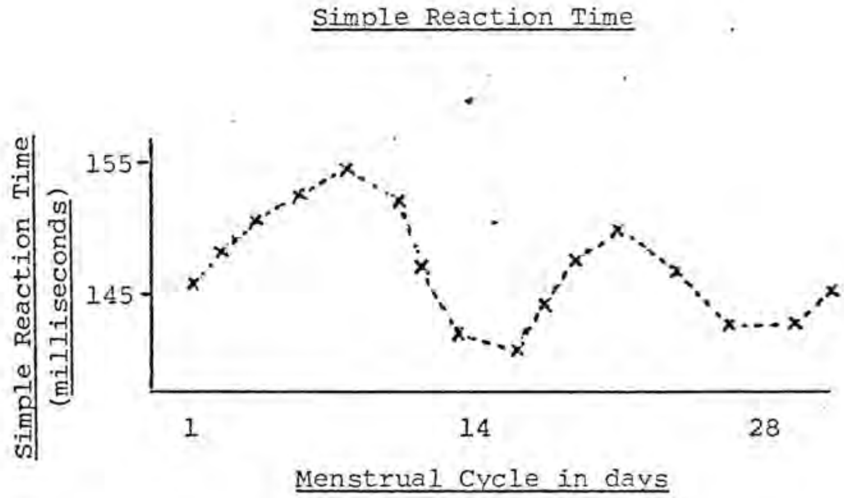
Bertalotti (1750) was teaching his Solfeggi (fixed doh) in the ordinary schools in Bologna - education played a great role in Italy's production of so many outstanding musicians.

Our present Tonic Solfa is based on the supremacy of the tonic and the mental effects of other notes in relation to tonic; there is no evidence that Guido D'Arezzo did this or that he had any idea of key, his mind was occupied with the practical use of semi-tones as valuable recurring landmarks. John Curwen (1816) changed 'ut' to 'doh' and 'si' to 'te' purely in the interests of speech training. In the 1958 original edition of the standard course of Tonic Solfa all work starts in the key of 'C', with practice on memorising 'C', all then proceeding via the tonic chord to the dominant chord followed by the subdominant, i.e. in the order of mathematical simplicity of their ratios of vibrations. With each name and the mental effect of each is described as follows:

Absolute Pitch measurements for one subject averaged over eight cycles (Wynn, 1972).



Simple reaction time measurements for one subject over six menstrual cycles (Wynn, 1972).



As V.T. Wynn points out, the variations of the A.P. estimates with time, or indeed the decreasing ability to acquire A.P. with the approach to puberty, cannot be fully accounted for by any change in the mechanical properties of the ear. The evidence he suggests, points to the possibility of the variation of A.P. estimates being caused by a neuronal mechanism. As he points out, this can be caused by a change in the sensory threshold level in the organ of Corti, or by some neuronal inhibition mechanism in the brain itself.

The experimental evidence of Wynn and Beardwood suggests that estrogen in the female and the androgens in the male and the gonadotrophins may play a part in A.P. measurements, not forgetting the previously observed decline in pitch learning apparently matching the rise of testosterona. If this is the case however, how is it that the most accurate learning of Absolute Pitch appears to take place long before puberty, possibly before six years of age? so queries A.V.Wynn.

Are we not talking about two different things, that is, on the one hand pitch memory and on the other hand changing sensory levels, and the affects of such changes on pitch estimates?

In the section entitled 'Age Factor', an experiment showing the changing ability in pitch learning of children according to their age, showed how puberty affected pitch estimates more than actual age. Professor Loer of Pretoria University, who has made a life long study of the Bantu, remarks, 'The only thing of significance in pitch perception among the Bantus, is puberty'.

The work in this thesis on the subject of hormonal influence on pitch learning, is little more than a preliminary investigation, aimed at pointing out that there appears to be such an influence which must be the subject of further research.

PERSONALITY IN PITCH LEARNING

A.E. Kemp's thesis, 'A Pilot Study of the Personality Pattern of Creative Music Students' is of value in that it suggests a criterion for the identification of creativity, the creative musician being the Productive, and the non-creative being the Reproductive Musician. His approach is justified by the two distinct personality patterns. It is however important to realise that his survey is concerned with music students and that presumably all would have spent some time at the mrely reproductive stage during the period when they were gaining basic technical skills, since these are mainly reproductive. It would be at this reproductive stage that Pitch would be learnt, as it could not be expressed in the form of a composition until it had been learnt. Perhaps it would therefore be useful to study the personality of the Reproductive Musicians for clues as to the personality most able to learn pitch.

This would suggest that the less bohemian, radical, bold and independent would stand greater chances of learning pitch. Since pitch learning requires interaction between the subject and his environment this could possibly be true. In order to compare the personalities of those learning pitch to the varying degrees, I used the 2IP Factors system of preparing a Personality Profile based on the work of Human Cyberneliasts, but I found no difference between those having acquired Absolute Pitch and any others. Rosamund Shuter in her paper, 'The Relationship between Musical Abilities and Personality Characteristics in Young Children' found that the only personality factors which showed consistent significant correlations with the music variables were 1+ (tender mindedness) and Qz+ (high self esteem). Hughes claims that tests show that social adjustment is related to the extent of musical participation. This should affect pitch learning, particularly at the pre-puberty stage.

The New York Project : While a report of the three year project in New York of introducing Music Education as an experiment in order to study overspill effects produced little of value, due to the basic lack of understanding of the audiological function, preventing the drawing up and use of a suitable syllabus of music education, the report did show that musical activities stimulated interest, enthusiasm, concentration and co-operation. If this is the case a study of the effects of motivation will immediately illustrate the importance of their findings.

The isolation of personality factors affecting pitch learning is difficult as pitch is learnt during the very early years of life; at an age which precludes the use of self-recording Personality questionnaires by the subjects.

SUMMARY OF SECTION IV

The more important that pitch discrimination is, for the subject during the optimum years of pitch learning, the greater will be the learning of Absolute Pitch.

A survey of children born blind and compared with normal sighted children and those becoming blind after the age of three years, showed that the greatest A.P. learning took place during the first three years of life.

All sixteen A.P. subjects tested played the piano.

None of the A.P. subjects played solely wind instruments. The three wind instruments players who had acquired A.P. also learnt to play the piano.

A greater percentage of those playing the piano in addition to the violin had acquired A.P.

None of the A.P. subjects learning only the guitar had acquired A.P.

All of the A.P. subjects had a parent who played an instrument.

Tone deafness, in the absence of physiological defects, is virtually unknown in communities using a Tonal language.

A.P. learning was greatest in Tonal speaking groups when:

(a) The language demanded pitch discrimination from birth.

(b) A great deal of practice went into learning A.P. from babyhood and a small vocal range was initially explored.

A.P. learning was also considerably higher among the non-Tonal tribes than among the European population, although this was not so great as among the Tonal tribes. Early involvement in pitch making activities appeared to be responsible.

Any language demanding clear vowel enunciation would assist pitch learning.

There is a definite relationship between learning of sounds and need.

It is whether the immediate environment provides music to be heard during the optimum years in a manner that is pleasurable to the child, that determines the learning of pitch.

The rejection of sound can be a barrier to its learning.

Distortion of sound caused by sensori-neural hearing losses can also cause rejection. A special type of hearing aid could prevent this.

Unlike the first learning of pitch with the pre-seven year olds which was better for intervals than melodies, older children scored better when pitch was presented in meaningful melodies.

Pitch learning increases with piano practice.

A consistent pitch is necessary for learning.

Absolute Pitch learning was the most accurate when tested on the instrument on which they first learnt. The notes most frequently used in childhood were the notes most easily learnt.

Timbre Perception, like all other aspects of pitch is learnt. A constant change of instrument during the early years could prevent pitch learning by giving too great a variety for each pitched note to enable learning to take place.

Pure Tones have little attraction for young children - greater learning of the more complex tones takes place. Is this one of the reasons responsible for the greater pitch learning shown by the learning of certain instruments?

In the absence of clinical defect the condition described as Tone Deafness should not exist as it is removed by training.

Amplification of the reference tone assisted 'tone deaf' subjects over eighteen years of age to sing in tune, but had the reverse effect on music students already capable of singing in tune.

'Tone Deafness' appears to be caused by insufficient practice in varying the vocal cord length to match the reference tone during the years when such control is gained, that is, the pre-puberty years.

Some pitch memory is needed for singing in tune.

Scalewise passages do not of necessity involve auditory practice, interval work does.

Amplification of the reference tone helped Tone Deaf subjects to sing in tune but did not produce any significant results in developing a Pitch Memory. Duration of reference tone is also involved.

If the individual's early life does not require him to discriminate between basic frequencies then he may become 'tone deaf'.

Pitch Discrimination Tests at the extreme ends of vocal range show greater errors; the process of vocalisation therefore appears to aid pitch learning.

The first learning of pitch must have already taken place before monitored vocalising can be achieved. Hearing is therefore considerably in advance of Vocalisation.

The activity of singing in tune, is in fact the establishment of an Auditory/Vocal Feedback.

Vocal range appears to be dependent on use for development. Falling Intervals appear to be learnt more quickly than Rising Intervals.

The slower child often shows better intonation than the quick child but is slower to identify notation.

Audio/visually presented material improved learning especially among those having received pitch training.

Pitch learning does not appear to be related to intelligence in the pre-puberty years, but does appear to be so related at the post-puberty stage.

The maximum use of other cues would need to be used to assist in pitch work after puberty.

Whereas free experimentation with sounds without guidance can merely lead to a realisation that we can produce a variety of sounds, with guidance it can lead to the development of self control and the critical listening necessary for pitch learning. Vitamins, adequate rest, physical exercise and fresh air all appear to aid pitch learning, as they do all other forms of learning.

The apparent greater musicality among girls over boys reported by many, is in my opinion artificially caused by the deprivation of opportunity for adequate training for boys during the optimum years.

Puberty affects Pitch learning more than age.

Experimental evidence suggests that hormones play a part in Pitch Memory/Pitch Measurements.

Personality appears to have little influence on Absolute Pitch learning although social adjustment appears to be closely related to 'musical participation'.

SECTION V

THE CONSIDERATION AND EVALUATION OF TEACHING PROCEDURES AND METHODOLOGIES IN THE FIELD OF PITCH LEARNING

Authoritarian Teaching

This is possibly the quickest means of getting over facts and/or coping with basic skills acquisition, requiring the great deal of repetitive drilling needing to be done during a certain developmental stage for the most effective learning of pitch. It requires the least ingenuity on the part of the teacher and makes possible the use of non-specialist teachers, since such drilling can be carried out by the following of written instructions.

The problem with this kind of teaching, is that it represses individuality. Because it can suppress response instead of stimulating and evoking response great care must be taken; research has shown that pitch learning is an interactionary activity in that not only must the auditory stimulus be presented sufficiently often and sufficiently loudly, but response must be evoked and attention attracted to the auditory stimulus. The auditory stimulus must have meaning and importance to the individual at its particular stage of development. Fortunately at the age when such work is necessary, most children can be encouraged to co-operate by an explanation of hearing and the need for hearing training, games can be played to present the sounds many, many times, encourage depth of critical listening and attention to the softest sounds possible. The introduction of both tonic solfa and staff notation is yet a further way of presenting the same sounds over and over again.

Discovery Methods

The greater amount of time required is the serious stumbling block of using these methods. With some guidance and control to ensure the right outcome undoubtedly the process is more interesting. It also gives scope for individuality of approach and hence the development of creativity. A great deal of preparation is necessary on the part of the teacher to prevent wastage of time, but it should be remembered that 'learning by doing' has been proved time and time again to be more thorough.

To guide the children to ensure the 'sufficiently often, sufficiently loudly' maxim necessary for pitch learning is extremely difficult. I personally found that discovery methods were very useful for developing critical listening and attracting attention to sounds, and were therefore best used in conjunction with the authoritarian drilling of pitch learning; discovery methods on their own did not satisfy the 'sufficiently often' maxim. The most effective activities for developing critical listening I found was the making of instruments and then tuning them, Music/Drama workshops where plays were written or presented with suitable sound effects worked out, and a variety of creative music projects which involved the collecting, exploring and experimenting with sounds.

The Use of Educational Technology

The National Foundation of Educational Technology defines Educational Technology as the use of technical devices to support processes of training and learning by the construction of systematic learning materials in accordance with an analytical approach to training and learning'. The process must include evaluation of results and involve planning and organisation. In the field of pitch learning its chief value would be the possibility of using equipment such as the Language Master and Tape Recorders for the simultaneous presentation of auditory and visual cues, with the added advantage for those learning out of the optimum period of being able to vary the amplification according to frequency range with the more sophisticated equipment. Such equipment would also be useful for the development of auditory memory. Self help study of a subject, such as pitch learning, where the older students' lack of self confidence and embarrassment at their inability often causes added difficulties.

Programmed Learning

This is very useful for enabling pupils to acquire specific skills or areas of knowledge allowing them to work at their own speed, without others being aware of their failures. A good programme provides the necessary stimulation. The method is particularly useful when dealing with pupils lacking in self confidence and having difficulty in communication.

Teaching Machines

This is programmed learning, involving some form of machine and as such its merits include all those under the above heading. They have the advantage of making trial and error tactics less easy for others to observe and therefore would be even more satisfactory for those lacking in confidence.

I have found the Bingley Tutor in conjunction with a Tape Recorder, a Language Màstér and a Visible Speech machine particularly useful, as they enable the child to compare his efforts privately with a given sample, and give sufficient practice in this in order to develop confidence in the individual's ability to listen critically and copy accurately and eventually test out their own memory. A Language Master which makes the repetition of short phrases or isolated sounds very simple to arrange, is particularly valuable.

Language Laboratory

Providing attention is paid to the need for <u>much</u> repetition of either single sounds or short phrases, together with the need for relating to a visual cue, then these are excellent. Unfortunately a lack of understanding of the simple facts of audiology render much present work in the language laboratory valueless, as the amount of repetition allowed for is usually insufficient. It should also be remembered that the following of scores while listening to records is bound to reinforce pitch learning - here then is a further use of the Language Laboratory.

Team Teaching

The only form of team teaching that I have found useful in the field of pitch learning, was when the class broke up into groups under a leader and went off to separate pianos to learn certain sounds or songs, as this made individual drilling more possible and introduced a competitive element.

The Selection of Training Processes

Having decided upon objectives one can list the variety of experiences most likely to attain these objectives, taking into consideration such factors as:

(a) Length of time required and available.

(b) Methods to be used.

(c) Equipment and space needed.

(d) Staffing factors.

(e) Theories of learning.

(f) Background noise.

One must also remember that the method must satisfy the performer and yet be within his capacities and be flexible in approach.

A STUDY OF THE TONIC SOLFA SYSTEM

Guido D'Arezzo, born in Paris about the end of the tenth century, devised a system which we now call the movable doh, when he took a Latin hymn written some four centuries earlier in which he noticed that each line began a note higher, and so he took the first word of each line, i.e. Ut, Re, Mi, Fa, Sol, Lah, etc.

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te - piercing or sensitive

lah - sad or weeping

soh - grand or bright

fah - desolate or awe inspiring

me - steady or calm

ray - rousing or hopeful

doh - strong or firm

The mental effects are dependent upon the key being established in the mind and upon the tones being sung slowly. Curwen reminds one of the effects of bodily and mental depression on our recollections. In the latter part of the standard course Curwen deals entirely with the speech training aspect. One interesting point is the mental effect of the tonic solfa, as described by Curwen and Leontev's description of the kind of hearing required for acquisition of non tonal timbre language, i.e. discrimination of timbre/colour of sounds as against tonal hearing for tonal languages and music. The work of Rousseau in the thought-out scheme of musical training in his Emile, ou de l'education (1762), shows some anticipation of Curwen arguing rationally in favour of what we call the 'movable doh'.

<u>Curwen</u> Pivot sound - doh

<u>doh - soh</u> Hand signs - doh - closed fist

soh - open hand with thumb pointing up.

Pattern must be heard first. Practice doh - soh from any doh, checking with the piano <u>after</u> each attempt.

<u>Me</u> Hand sign - open hand with the palm facing downwards

- doh - soh - me

Changing pitch of doh, sing:

(a) Doh, Soh, Me, Soh, Doh

(b) Doh, Me, Soh, Me, Doh

(c) Doh, Me, Doh, Soh, Me

(d) Doh, Soh, Doh, Me, Soh

(e) Soh, Doh, Me, Soh, Doh

Add Ray, Te

i.e.: d m s d r d   d m s d t d

Hand signs Ray - open hand, spread fingers and palm facing outwards.

Te - forefinger pointing upwards.

Add Fah, Lah

Hand signs Fah - forefinger pointing downwards.

Lah - hand hanging down from wrist.

Learn notes by solfa, then sing to a uniform vowel like la; then sing the words.

The Perpendicularly arranged scale should be constantly used, i.e.

Doh

Te

Lah

Soh

Fah

Me

Ray

Doh

If necessary at this stage, study staff notation.

- - - - - - - - - -

Rule 1 : If doh on a line then Me, Soh, next two lines etc.

Rule 2 : Octaves are alternately placed, line and space.

Rule 3 : Ray is next above doh, te is next below, etc.

Rule 4 : Alternate notes of the scale are always similarly placed.

Then comes duration of notes.

In Tonic Solfa 'pulse' equals the distance from accent mark to the next.

As already explained, the Tonic Solfa system is based on the learning of the Mother Tongue by associating each pitch degree with the learning for language that has already taken place during the optimum period of such learning. The system is therefore bound to result in the learning of Relative Pitch, because like language, it is concerned with the relating of auditory and visual cues reinforced by spatial, tactual and kinaesthetic cues and follows all known laws of learning.

The Place of Tonic Solfa in Relative Pitch Learning

In language each vowel has its own place in the frequency scale which it retains at each wave-band. Tonic solfa syllables do likewise - the wave band being the octave. It follows therefore that since the Tonic Solfa is based on language by the Law of Facilitation alone, there is a greater chance of pitch learning by this method and any other which is likewise based on the mother tongue. The connection between speech and Relative Pitch Acqusition can be heard in any recording of speech sounds recorded in frequency order.

Bentley, in his 'Musical Ability in Children', remarks that it is the common experience of secondary school teachers of children of twelve years of age or over, that attempts to teach the naming of pitch sounds meets with only limited success, and even at times with resistance. It would appear that the optimum period for acquiring this skill is in the earlier years of the Primary School. Bentley then observes that in the naming of the sounds, absolute pitch names are of little use to the majority, numbers take no account of chromatic semi-tones, solfege with its fixed doh, suffers from the same limitations, but solfa syllables not tied to fixed pitch are simple and logical. Many experiments have taken place to determine which scales to use to enhance pitch learning, but analysis shows the difference in frequency between scales is only slight, and well within the just noticeable pitch difference limen (minimum of nerve excitation required to produce sensation). According to Bentley, violinists and singers performing without keyed instruments tend to produce intervals nearer to the true diatonic scale, therefore it would appear that commensurate ratios are the requirement of a pleasant musical feeling. (See Helmholtz theory of hearing and importance of consonant intervals, and Scholes (1950) suggestion that the ultimate origin of scales lies in speech inflections.)

After the Pythagorean diatonic scale, musical scales were influenced by worship. Following the death of Christ plainsong became important; later, minor scales were introduced for solemn or reverent effects and semitones were introduced in equal tempered scales and used as extra embellishments. Therefore it may be that the developments and variations of the mathematical scale (Pythagoras) were just a step in an evolutionary process. John Blacking claims however that musical scales are based on what man has chosen to select from nature as part of his cultural expression rather than on what nature has imposed on him. History shows resistance to contemporary music and it may be that experiments taking place with new scales, will give more evidence on whether the human ear can be adapted to a departure from the consonant intervals considered so important by Helmholtz. The success of children starting to learn Relative Pitch using the Tonic Solfa system, after the hearing acuity has declined too much for acquiring Absolute Pitch, demonstrates how Relative Pitch is <u>second learning</u>. As although the exactness of pitch learning is no longer possible, the degree of the first learning of pitch that has taken place in the optimum period to make speech possible, can be utilised to learn Relative Pitch for musical purposes providing the association is with language as that is the known quantity. It is this known quantity that can be associated with musical notation to develop Relative Pitch. It is this factor which has made the Tonic Solfa system so successful, for as Leontev says, 'the ability to hear a tone or timbre develops concurrently with mastering a language'. (In dealing with language deviant children I also found the converse to be true.) It is further observed that the use of hand signs in the teaching of tonic solfa could be a means of introducing a kinaesthetic cue as reinforcement, but a study of the effectiveness of the Curwen-Kodaly Hand Signals carried out by Charles Hoffer, of the School of Music, Indiana University, showed no significant effect resulting from the use of hand signals. The research of the Soconomy Oil Company showing the dominance of learning via the visual sense, would indicate that at best the hand signals and the resultant motor/kinaesthetic experience could only reinforce learning, and that any attempt to use them in the place of a visual cue such as notation could impair the learning.

THE HUNGARIAN MUSIC EDUCATION SYSTEM - KODALY SYSTEM

The success of the Kodaly system in Hungary for the development of music literacy (and this I suggest is what it does develop), appears to have its origins in the fact that it is a system, and that the system is based on the proven audiological maxim of 'sufficiently loudly, sufficiently often' during the optimum years (i.e. pre-puberty). The material is based on the environment of those learning it, that is, the music of the Folk. In Hungary, most folk songs begin with s, m and s, l, m. Therefore the system starts with this, simply because it is recognised by educationalists that one must start with the known, in order to introduce the unknown. A Kodaly system used in any country must therefore be based on the musical heritage of that country, and not on the foreign culture of Hungary, and it must include considerable listening and vocalising practice with a suitable visual cue, such as the tonic solfa syllable and must be used during the early years for fluent literacy to develop.

An essential part of the Kodaly system is the use of the folk songs in early training. From my discussions with Kodaly's contemporaries and study of his writings, it would appear that his approach via the Hungarian folk song is very largely because this is the music of the Folk, and therefore what would be heard by the ordinary child in the house long before formal music training took place. He found that this early learning was responsible for the development of pitch memory, and so the best results could be gained by sufficient experience of this folk music at the early stage in order to build up a system of Relative Pitch at a later stage. Since this is entirely consistent with the audiological functioning of the child it is bound to succeed. Unfortunately however, many teachers from other countries have failed to realise that it is the 'Music of the People' available daily in the homes that is required for the beginning of the Kodaly system, not Hungarian folk songs. When they are introduced as a foreign culture it removes the effectiveness of the system as they are not the songs that the child has learnt during the early years in his home on which to base the tonic solfa system. One cannot relate two unknowns.

<u>The Kodaly System</u> (Extract from publication by Zeneműnyomda, Budapest)

Zoltan Kodaly devoted a significant part of his creative activity to the music education of the whole Hungarian people and to the creation of Hungarian culture. The greater part of this educational programme was in the service of the musical education of young people. The basis of his pedagogical work and his educational conception 'to bring as large numbers as possible into direct contact with real, valuable music...' The system of objectives of Kodaly's music education conception - which is today the basis of state curricula, is as follows:

(a) To offer a unified, basic music education to every child in his primary school years, that is until he is fourteen, then to be continued in the secondary school. The way towards this being:

i) Singing based work.

ii) Worthy material for study/folk music, Hungarian and universal art music.

iii) The method of relative solmicization.

(b) Conscious use in personality formation of the pedagogical possibilities of education by music, and in the formation of a many-sided, balanced person.

(c) The creation of balance and correct proportions between the training of professional musicians and education of the public.

For the realisation of the above basic principles, for the collecting of material and the evolution of the methods in connection with this, Kodaly needed more than half a century. Kodaly wished to make the Hungarian folk song the basis of Hungarian music pedagogy principally because it is simple, and so that the Hungarian child should sing in his musical mother-tongue. Once the material was ready, all that remained was to create the special methods to fit it. It required a great deal of care and work to seek and build up the methods and methodical progress appropriate to the tone and style of the Hungarian musical material, the method based on relative solmicization.

The essential points in relative solmicization begin with the idea that the keynote of every major scale should be 'Do', and that of every minor scale 'La'. Thus the recognition and singing of the once innervated intervals - even if the melody's key signature contains five sharps or six flats - does not present any particular difficulty to the pupil. This system in the hands of a suitable teacher, even at the very beginning of study produces sure music reading and intonation. The didactical and methodical order of the process of music education is built on the Kodaly conception. In this process the way to familiarity with music is as follows:

From active observation / from living music / to abstract thinking / the making conscious of musical elements / and from there to practical / independent / application.

The process of training; the pupils learn songs by ear, meanwhile becoming familiar with the basic temporal / rhythmic / pitch / melodic / dynamic and tone-colour relationships. During this their hearing develops. In connection with the songs they gain intellectual, emotional and aesthetic experiences; their ability to experience and 'live' music develops, as does their capacity for singing, their breathing control, and their speech. Then the musical meaning-system becomes independent from the text of the songs, they make the musical knowledge their own, make it conscious and through practice they gain ability in recognition of music, the notation of it, the reproduction of symbols / hand signs, letter-symbols, notes.

In this process the following activities and objectives are closely inter-related:

(a) Singing, song learning. Beautiful and expressive singing.

(b) Choral singing, polyphony. Listening to music.

(c) Teaching of musical knowledge / elements of music, phenomena of folk music and art music.

(d) Development of rhythm and melody hearing.

(e) Development of the ability to read and write music.

(f) Realisation of the educational aims and objectives.

The song, living music, is the source of all musical knowledge and experience. The children sing a great deal during the lessons. They accompany their singing with movement and rhythm instruments, and play to them. Their singing is coloured by variations in tone-colour and dynamics and in this way new possibilities are opened up for varied singing and for observation of living music from several angles. Many different kinds of auxiliary aids, melody and rhythm cards, magnetic boards, use of hand signs and letter signs, help towards the familiarisation of musical elements, conscious hearing, reading and writing of these. Gradually and through play, they reach the point where the seen notes change to living music within them, and they can imagine it and realise it in practice.

The music teaching concerning every primary school pupil while he is of compulsory school age, that is between six and fourteen years, is organically complemented by the instrumental teaching carried out in the 110 state music schools. In these schools approximately 50 000 young people become acquainted with the instruments and penetrate the depths of art music. Here the Kodaly system naturally works in a different way from the singing teaching of the general schools; the main characteristics in which present-day instrumental teaching differs from that of earlier times are as follows:

(a) A preparatory year without any instrument, where rhythmic sense and hearing are developed and the children learn the basic elements of music reading and writing.

(b) In all classes the study of solfege is compulsory alongside instrumental studies.

(c) From the second-third years onwards, there is a significant difference in the quantity of work to be accomplished, and in the examination requirements between those preparing for a professional career in music and those studying with no more than the demands of an amateur musician.

(d) In both areas an outstanding role is played by group music-making in all forms, chamber music and orchestral work.

(e) In instrumental study it is also a basic principle that we teach only valuable, artistic music. Thus in the early stages it is principally Hungarian folk songs and folk song arrangements that we teach here too, for following the preparatory year and solfege teaching it is with these that we can fulfil most easily Kodaly's requirement that the child should play on his instrument what he can imagine musically.

In the interests of realising the above principles, we have in the course of the last two decades published a new 'school' for the teaching of the beginnings in <u>every instrument</u>, in some cases several for example, piano and violin. In recent years these have won increasing success abroad as well. The schools are organically supplemented by pieces by young Hungarian composers, a whole series of chamber works and collections of these. <u>The following are quotations from the writings and speeches of Zoltan Kodaly - Visszatehintes published by Zenemukiado, 1964</u>. It has been shown that no musical knowledge of any kind can be acquired without the reading of music. Experience has proved that the children learn to read music more quickly through using solfa than using the note names, as it indicates not only the relative pitch but also the tonal function of each note along with the feeling for intervals. The way of getting to understand music is accessible to everybody; it is musical reading and writing. Having mastered this anybody can participate in great musical experience. The properties of good musicians can be summarised as four things - cultivated hearing, intelligence, heart and hands. Basic training neglected in youth can not be made up for later - he who by the age of fourteen has not learnt to read and write fluently can then learn it only with great difficulty or not at all. In his book, 'Music Education in Hungary', Frigyes Sandor describes in detail the system showing how each stage is introduced, the results and eventually the effects of special music education on the whole development of the child, and includes a quotation from Leonard Bernstein saying that the language of a race is reflected in its music: 'their language grows into musical notes'. It is often not realised that the Kodaly method requires children first to learn the folk songs of their own people and not of foreign cultures. (Szönyi, E., 1974)

Justine Ward in her system, 'That all may Sing', believed that every child whose musical education was begun at the age of six, and carried on progressively and logically during the early years of his school life, could be brought:

(a) to sing;

(b) to read music from staff notation;

(c) to improvise;

(d) to compose;

(e) to conduct

with as much ease as he would learn to read, write, and express himself in his mother tongue. She believed that:

(a) The seeds of music exist in every child waiting for discovery and a gradual unfolding.

(b) The work of fostering this in every child is best suited to the ordinary class teacher, as it was more important to know how to deal with young children than to have a great quantity of specialist knowledge. In fact it should be introduced in no other way, since professional musicians are not capable of spending their time day by day nurturing the gradual unfolding, nor have many the understanding of child psychology, or the patience or tact required for music to be a growth from within. Advisory visits were advocated from the professional musicians and also she recommends that music should be taught in short daily lessons of twenty minutes initially, followed by a simple logical exposition coping with one thing at a time. She claimed that a child of six can sing E to E^1, to the syllable 'Nu', pronounced 'Noo' with an exaggerated buzz of prolonged nnnnn, thus directing the sound forward and upwards. In this way the child learns to listen and express itself and develops critical faculties. Later the Nu-o-A quality can be opened and other vowels added, with all the material to follow the current stage in pitch and rhythmic learning but slightly delayed.

The difference of pitch should be taught with the help of gesture and the major scale built up stepwise with guessing games using the ear and eye, as part of their training. A vertical study of intervals should be made by singing notes of the tonic chord to dominant and sub-dominant, etc. Flash cards could be used for drilling purposes. Rhythm should be taught through gesture and motor experience. Justine Ward also stressed the need for original creative work, with the child creating something out of the elements he possesses.

Yorke Trotter (1854-1934)

Trotter's chief interest was in the musical education of the young. His principles of teaching were based on the study of the child and the way in which its mother tongue was developed. He stressed the similarities of music and language in their component parts.

Yorke Trotter not only studied the child's mind but also insisted on the need for a feeling of love which drew response from a child. He insisted that chords were heard and used and not merely learnt from books, so that in time the ear was trained.

He believed that creativity is a latent force in mankind, which can be the mainspring of a tremendous activity of mind, and that it existed in all children and not only those labelled talented.

Extracts from speech given by Carl Orff at the opening of the Orff Institute in Salzburg:

ORFF-SCHULWERK : PAST AND FUTURE

To understand what Schulwerk is and what its aims are, we should perhaps see how it came into being.

A new feeling for physical activity, for the practice of sport, gymnastics and dancing had seized the youth of Europe. The work and ideas of Jaques-Dalcroze that had spread all over the world helped considerably to prepare the ground for a new interest in physical education. Laban and Wigman, to mention only two names, were near the zenith of their careers. Rudolf von Laban was without doubt one of the most important dance teachers and choreographers of his time, and his writings about dance made him internationally famous. The highly gifted Mary Wigman, pupil of Jaques-Dalcroze and Laban, created a new kind of expressive dancing. The work of both these had considerable influence in artistic and educational circles and it was at this time in Germany that many gymnastic and dance schools were founded. In 1924 in Munich, Dorothee Guenther and Carl Orff founded the Guentherschule, a school for gymnastics, music and dance. Says Orff, 'Here I saw a possibility of working out a new kind of rhythmical education, and of realising my ideas about a reciprocal interpenetration of movement and music education. The speciality of the Guentherschule lay in the fact that one of its founders was a director and also a musician. This meant that from the beginning there was a special emphasis on all musical work and I found the perfect experimental field for my ideas'.

After some experiments with various exotic types of flute Orff decided to use the recorder, which up to then had suffered a kind of museum-piece existence. Through the particular assistance of his friend Curt Sachs, who was then in charge of the famous Berlin collection of musical instruments, Orff acquired a quartet of recorders copied from old models, consisting of descant, treble, tenor and bass. As bass instruments, in addition to timpani and the lower barred instruments, they used string instruments such as cellos and viola da dambas to provide a sustained drone bass. Guitars and lutes were also used as plucked strings. With these instruments their ensemble for the Guentherschule was settled. It was clear that for this ensemble new music would have to be written, or else already existing suitable music would have to be arranged and the first to be considered was both native and foreign folk music. Orff's idea was to take his students so far that they could improvise their own music (however unassuming) and their own accompaniments to movement. The art of creating music for this ensemble came directly from playing the instruments themselves. It was therefore important to acquire a well developed technique of improvisation, and the exercises for developing this technique should above all lead the students to a spontaneous, personal, musical expression.

In 1930 the first edition of Schulwerk called Rhythmic-Melodic Exercises appeared. Further books followed in quick succession. Exercises for percussion and hand drums - exercises for timpani - exercises for barred percussion instruments. From the beginning, Orff's pupil and colleague Gunild Keetman played a decisive part in the establishment of the instrumental ensemble and in the preparation of all publications. Orff's assistants at the Guentherschule at that time, Hans Bergese and Wilhelm Twittenhoff, were also involved. In addition to, and as a result of these educational enterprises the Guentherschule dance group came into being with its accompanying orchestra, for which Gunild Keetman wrote the music and Maja Lex worked out the choreography. At their performance, dancers and musicians were able to exchange their functions. To give some idea of the wide ranging variety of the dance orchestra here is a typical combination: recorders, xylophones of all pitch ranges, metallophones, glockenspiels, timpani both large and small, all kinds of drums and tom-toms, gongs, different kinds of cymbals, triangles, bells of fixed pitch, antique cymbals (Indian bells), claves, viola da gambas, spinet and portative organ. The dance group toured all the year round in Germany and abroad, and attracted much attention. In addition there were educational demonstrations that contributed significantly to the spreading of the Schulwerk idea. The unity of music and movement, that young people in Germany have to be taught so laboriously, is quite natural to a child. This fact gave Orff the key for his new educational work. It was clear to him what Schulwerk had so far lacked. Apart from a few painful experiments they had never allowed the singing voice and the spoken word their rightful place.

Now the call, the rhythm, the word, the song, were the decisive factors, for with children, it could not have been otherwise; movement, singing and playing became a unity.

Now everything fell quite naturally into its right place; elementary music, elementary speech and movement forms. The melodic starting point was the cuckoo-call, the falling third, a melodic range of notes that was increased step by step to the five-note pentatonic scale that has no semi-tones. Speech started with name-calling, counting out rhymes and the simplest of children's rhymes and songs. This was an easily accessible world for all children. Year in, year out, many Schulwerk courses are given for teachers of all kinds. Schulwerk is taught alongside other subjects in various schools of music, in schools for gymnastics and dance, and in private courses. Useful as all these efforts may be, they do not alter the fact that Schulwerk has not yet found the place where it belongs, the place where it can be most effective and where there is the possibility of continuous and progressive work, and where its connections with other subjects can be explored, developed and fully exploited. This place is the school; 'Music for Children' is for the school.

It is at the primary school age that the imagination must be stimulated and opportunities for emotional development, which contain experience of the ability to feel, and the power to control the expression of that feeling, must also be provided. Everything that a child of this age experiences, everything in him that has been awakened and nurtured is a determining factor for the whole of his life. Much can be destroyed at this age that can never be regained, much can remain undeveloped that can never be reclaimed. Carl Orff is disturbed by the fact that today there are still schools where no songs are sung, and many others with very defective music teaching. The challenge is clear, elementary music has to be included as a central subject, not as one amongst other subjects.

The speech, given by Professor Carl Orff at the opening of the Orff Institute in Salzburg on 25th October 1963, is published by kind permission of B. Schotts Soehne, Mainz, from the Orff Institute Jahrbuch, 1963. Translated by Margaret Murray and included with her permission.

Orff-Schulwerk in Practice

In my opinion the Orff instruments are designed as no others are, for the classroom situation. This was the purpose of Orff's Schulwerk and in practice this is what has developed. It remains for the educationalist to use them in the manner for which they were developed.

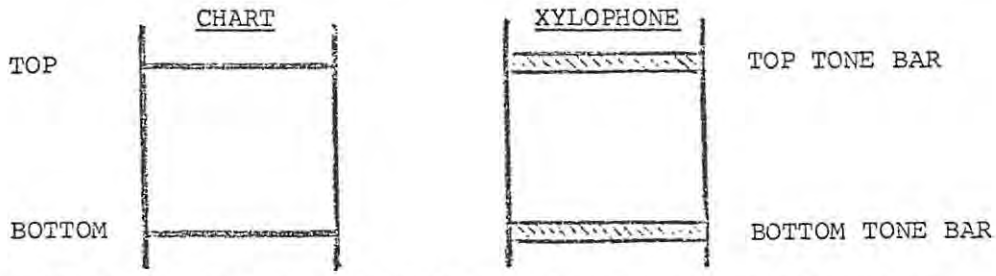
The classroom situation requires instruments which are sturdy and 'child-proof', simple to operate, possible to organise in a large group producing a pleasant musical experience for each individual child in a large class, and at the same time are capable of being beneficial educationally and suited to the child's development needs. They must be capable of being used progressively to bring about development and literacy as well as self-expression and so adapted that each concept to be taught can be produced logically and singly. It is only the Orff type instrument which can produce a single teaching situation at a time - all other instruments produce so many possible situations that the teaching becomes more difficult, e.g. a xylophone can begin with two notes, all others being removed so that work can begin by discriminating between high and low notes. The use of these instruments by the audiologist, to test a young child's hearing shows how ideally suited these are to the Nursery and Primary Schools. Observant teachers trained to understand simple audiological principles will be capable of picking up cases of slight and variable hearing losses which cause so many speech defects, reading and spelling failures. A good teacher will probably get far better results than the clinical audiologist, because they can be done in the form of games, e.g. in the normal classwork and as part of a regular daily activity without the child being aware of being tested and so tension and anxiety are absent.

Audiologically the child's hearing for absolute pitched sounds is at its most acute during the first three years of life, starting to decline by the age of six years, and appears to be so reduced by puberty that first learning in Absolute Pitch becomes impossible. Fortunately once learnt a sound only requires about 50% hearing to remember. This is why the Primary School stage is so vital for music - all further development is dependent on what has been learnt during the Primary School. Relative Pitch, the associating of one sound to another already learnt, assisted by a visual or other cue can be reinforced later, but is dependent on the degree of first learning of pitch that has taken place for many aspects of its development. Rhythmical Development does not begin to show any decline until approximately the age of eighteen years. It is therefore essential to concentrate on the use of the Orff Pitched Instruments for pitch learning and not, as so many do, ignore these and concentrate on the mere percussion. The priority of the Primary School must be pitch learning. Secondly, a young child's hearing acuity at first is for individual pitch sounds, not for scalewise passages - the bigger the interval between the notes, the more easily they are discriminated between and so step number one should be:

soh

doh

which is the limit of the average six year old child's vocal range. The tone may well be rather breathy in quality, but accurate intonation is possible. The notes should be sung softly as the child plays it. One must remember that the growth spurts of the vocal cords during the first six years of life makes the singing of sustained notes unreliable, but vocalising in response to pitch does bring about greater pitch learning. It is the pitch learning of the pre-puberty child that must have priority over all other learning since that is entirely age controlled. At 2½ to 4 years the child will happily play the correct note on the xylophone when shown a chart to match the xylophone, i.e.



but thinks only of the top or bottom note. He can be trained to continue playing on a pitched bar while a note appears on the chart and to stop when it is removed and gradually associate the symbol with a sound. Prior to this age there appears to be no ability to associate sound and symbol. If one points to the chart and asks them to play that note on their instrument, they will come running up to the chart to touch it in spite of the reference to their instrument. Play the sound on an instrument however, and they will reproduce it on their instrument. Cardboard Notes, which can be moved from one line to another, show the child by implication the association of notes with pitch, but at two to three years of age he can only accept the spatial element between two pitched sounds and no other relationship. One other aspect of the very young child is that during the acuity for absolute pitch his response to sounds is different. The first response to pitched sound is one of delight. He appears to learn the sounds very easily because he discriminates between pitched sounds produced interval wise immediately, whereas the older child needs to practice. Once he has done this, however, usually by the third session he is failing to respond, almost as if he fails to hear them unless they are produced in such a way that it is a new situation. This is basically because his hearing at this stage is still survival hearing acuity where new sounds attract attention, but a sound once familiar no longer represents danger or is considered worth notice. While the child is still at this stage therefore it is important to play games to attract attention to pitch, but not to assume that a child is regressing when they have passed the first response stage to sound, or just being naughty. It is vital that the sessions are pleasant and important - audiology has shown that a child can reject the learning of sounds to the point of failing to speak, if the experience is not pleasant and meaningful.

Another audiological principle is the 'sufficiently often - sufficiently loudly' rule for the learning of sounds. Hundreds of repetitions at a level sufficient for the child to hear must be available. At best the repetition of the sound must be produced in a variety of ways to prevent boredom and consequently rejection. The more intelligent the child the more difficult this is, since the threshold of boredom is reached more quickly. One other important fact is that children will when possible, respond according to their own needs. If he is frustrated or has a hearing difficulty, he will bang extra loudly on his instrument. An observant teacher will explore the cause of this banging to see if either of these reasons exist and take the appropriate action. At approximately four years of age a child is capable of relating a sound to a symbol and so in addition to the spatial element being used on charts to discriminate between pitched sounds, notation can be taught. Hitherto a note placed on a rung of a ladder merely meant that the appropriate tone bar was struck by the beater all the time the note remained on that rung of the ladder. At about four years of age one note on the ladder meant one sound, two notes two sounds, etc., but duration of sound related to symbols merely meant long and short, i.e. ♩ short sound, 𝅗𝅥 long sound. At five years of age the child could easily point to the rung of the ladder and play the correct pitch and sing it to tonic solfa. He could also manage ♩ = doh, but 𝅗𝅥 = doh-oh and ♩ + ♩ = 𝅗𝅥 , a piece of string was attached to the back of each note and tying them together demonstrated how they added up to the longer note.

The reading of the music from a specially prepared stave goes hand in glove with the playing of the Orff instruments. If mere repetitive teaching by rote is used, the children will soon be placed in the situation of being unable to do more than explore or only play when the teacher is present to tell them what to do.

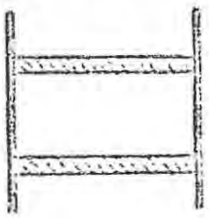
With literacy the children can recreate music for themselves. The child is capable of being musically literate and so what he can do, he must do. When teaching a young child to read music via the Orff Schulwerk, care must be taken not to create contradictory situations and thus prevent learning, e.g.

The chart shows a two-runged ladder:

(G)

(C)

The xylophone has two tone bars on it to correspond to the chart:



G Tone Bar

C Tone Bar

The xylophone can be held up alongside the chart to demonstrate. The youngest child will then be capable of playing either tone bar according to the one you are pointing to on the chart. If notes are used on the charts they must be cut out objects and not drawn on, as the young child can first relate a sound to an object more easily than to a symbol. After 'soh' and 'doh', 'me' can be introduced - at first as the 'middle' sound, later as 'me' in tonic solfa. Once again the Chart and Xylophone must agree. Once this has been coped with, the first stepwise note comes, i.e. 'lah', then 'fah' and then 'ray'. Each one must be first introduced as an interval, i.e. 'doh-lah' should be played and if possible sung, then tunes on 'd', 'm', 'soh', 'lah', etc. Far greater accuracy of learning occurs when the notes are first introduced in isolation interval wise, rather than allowing the mere extension of a sound to the next one scale wise. Singing intervals requires auditory discrimination, but scale wise work is possible by vocal experimenting with the minimum of auditory work. Once the diatonic scale has been completed, accidentals, time and key signatures and musical terms, can be introduced and the children become completely musically literate. If it is done pleasantly so that the child is eager to go on to 'grown-up' instruments then the Primary School teacher has done his job and the child can then move to an instrument, capable of reading and hearing music, and therefore only having to cope for the first time with the technical aspect of the particular instrument. If a child has only to do one thing at a time he is far more likely to succeed, and with success he is capable of fulfilment, satisfaction and therefore enjoyment.

Simple rhythmic work can be introduced by teaching each child to conduct the ensemble, this gives the point to the understanding of time signatures and so each ensemble practice can become a complete musical experience. Surely this is the purpose of the Orff Schulwerk. The full range of pitched instruments should be used for variety of tone and pitch and use of the bass clef. Part playing introduces the pupil to harmonic awareness. Rhythmic patterns can be introduced on non-pitched instruments such as the drums, triangles, tambourines, castanets, etc. In this way the child will only have to deal with one learning situation at a time. Orff recommends three steps to be followed in the introduction of new material: (a) Listen to the sound. (b) Experience it through movement, body sounds and speech rhythms. (c) Transfer it to the instrument, and lastly, present the notation or symbol.

THE SUZUKI VIOLIN METHOD

Taught to mother and child - first by listening and then by constant repetition, the emphasis is on listening. The Talent Education Method begins at birth. The child must listen to the reference recordings every day, progress depends on this listening. Stress is placed on a production of a beautiful tone, accurate intonation, correct posture and bow hold.

In Suzuki's own words, 'Musical ability is not an inborn talent, but an ability that can be developed'. Dr. Shinichi Suzuki describes his method as 'a method of education in the native language applied without any essential modifications to musical education'. In his book, 'Nurtured by Love', Suzuki remarks that a child having the intelligence to master the complexity of speech has the innate ability required. He shows how Peeko heard a sentence 3 000 times over two weeks before he repeated it - the next phrase was mastered after hearing it only 200 times, and so on with the 'bud of ability' taking hold. He also observes that it is not generally realised that nightingales are actually taught to sing in this way, they are not born able to sing. 'We need to understand the importance of the ear', says Suzuki. 'We must study how to develop talent through education and we must realise that talent, not only in music, but in other fields as well, is not inherited'. The importance of the environment can be seen in the case of Amala and Kamala, the two 'wolf' children found near Calcutta. What does not exist in environment is not developed - superior environment creates superior abilities as man adapts to environment. Ability is life - to like or dislike has no bearing at all. Young people should come into contact with distinguished people, the memory must be trained, ability grows as it is trained.

Science does not pretend to explain what it does not understand, so people who know anything at all about science should not voice opinions such as 'inborn talent' in regard to human ability. What does science really know about human potentials at birth? 'To reason whether one has talent or not', says Suzuki, 'is to no avail. Abandon these thoughts and use your own power to create talent, sincere training fosters intuition'. Talent education is not to train children to be professional musicians, but to be fine musicians, and to show a high ability in any other field they may enter. 'It' [the optics of motion], says Einstein, 'occurred to me by intuition and music is the driving force behind this intuition'. 'Mozart', claims Suzuki, 'taught me to know perfect love, truth, goodness and beauty'. When the human created the culture of speech and writing, it also produced the sublime culture called music. It is a language that goes beyond speech and letters, a living art that is almost mystical. The human heart, feeling, intellect, behaviour activity force, man is the power of the life force that controls human seeking and finding.

<u>Principles of Study and Guidance</u> : Four essential points for teachers and parents:

(a) The child should listen to the reference recordings every day at home to develop musical sensitivity. Rapid progress depends on this listening.

(b) Tonalisation, or the production of a beautiful tone, should be stressed in the lesson and at home.

(c) Constant attention should be given to accurate intonation, correct posture, and the proper bow hold.

(d) Parents and teachers should strive to motivate the child so he will enjoy practicing correctly at home.

Education for Musical Sensitivity : Every day, children should listen to the recordings of the music they are currently studying. This listening helps them make rapid progress. It is the most important factor in the development of musical ability. Those children who have not had enough listening will lack musical sensitivity.

Tonalisation for Beautiful Tone : Just as vocalisation is studied in vocal music, so Suzuki has introduced tonalisation into violin study as a new method of education; it has proved to be most effective. Tonalisation should always be included in each lesson and should be a part of the daily practice at home.

Group Lessons : The adoption of a new kind of group lesson in which more advanced and younger students play together is extremely effective. The students progress remarkably while enjoying the lessons. Dr. Suzuki recommends that group lessons be held once a week or at least twice a month.

Private Lessons for Developing Ability : A child should not proceed to a new piece simply because he has learned the fingering and bowing of the present one. His ability must be cultivated further as he plays this piece. Dr. Suzuki would say to the child, 'Now you know the notes, we can start very important work to develop your ability', and he would proceed to improve his tone, movements and musical sensitivity. The following point is also important. When the child can perform piece 'A' satisfactorily and is given a new piece, 'B', he should not drop 'A' completely, but should practice both 'A' and 'B' at the same time. Continuously reviewing pieces that he knows as new pieces are added will develop his ability to a higher degree.

Mothers and children should always observe the private lessons of other children. Lessons should vary in length according to the needs of the child. Sometimes a child may have a short lesson, stop and watch another child, and then return for more instruction. The Suzuki method, like all other 'mother tongue' approaches, concentrates on training the hearing during the early years. With the violin this approach should be particularly successful because of the child's early acuity for high pitched sounds, which can be experienced in a way that is impossible vocally because of the immaturity of the vocal cords, and the limited vocal range. Add to this the fact that the violin by the position in which it is held will present to the tympanic membrane the strongest possible stimulus, via air conduction supported by bone conduction, and one may have the best possible learning conditions. Theoretically therefore violin tuition by the Suzuki method should provide optimum conditions for the greatest acuity of pitch learning as in Absolute Pitch, providing the stimulating sample is of sufficient quality - as it is unhampered by the vocal restrictions or the equal tuning of the pianoforte, which is therefore a more suitable instrument at the relative high pitch. Studying recordings of the results of this training it was obvious that the continual listening training resulted in:

(a) Exact intonation.

(b) Good tonal quality.

(c) The exact imitating of musical phrasing copied to the minutest detail of shading; the result was a sensitive and musical performance albeit a reproductive one rather than a productive one.

In a study of the development of LITERATURE and the ARTS generally, the usual practice is to train by the experiencing and studying of acceptable works, until sufficient technique is acquired for the student to experiment with ideas of his own. The difficulty always is to provide sufficient training for the acquisition of the basic skills, without stifling individual desires of creativity - the linking of the two being the difficulty, since there always appears to be a quality present which does not appear to be the result of teaching, defies analysis, but turns a reproductive performance into a productive one, before it becomes an interpretation or creation. It is not anticipated that the Suzuki method would breed a vast number of professional musicians, but rather provide a suitable training to make the maximum use of each child's potential in music, or any other field of learning, where a hearing system trained to its maximum potential is of benefit.

The value of teaching the mother to teach her child in order to provide the optimum conditions, i.e. short but frequent sessions, given by someone with whom there is a deep bond, can be shown by the highly successful results achieved by the Ealing Centre for Mothers and their young deaf children.

THE YAMAHA METHOD

This method is based on the belief that music is born in all children and that 80% of the development of hearing for the entire lifetime takes place between the ages of from three to seven years.

The method also matches the physiological development by moving from unco-ordinated to co-ordinated movements in response to rhythm. The development of learning processes is similarly matched by progressing from intuitive, imitative activities to those requiring intellectual understanding. A 'feeling' for a musical idea is first instilled and then followed by learning to deal with it. Imitation leads to creativity through the medium of musical games. The keyboard is used as a tool - the goals being:

(a) To give the child the facility to produce on the keyboard the sounds he hears.

(b) To allow the child the chance to relate musical sounds to musical pictures.

(c) To teach the child the basics of musical notation.

All the work at this stage is organised in groups and is enjoyed by the children far more than the individual lessons. The emphasis throughout the method is on ear training, the keyboard is used only as a convenient tool in teaching the fundamentals of music.

Parents are encouraged to attend the classes in order that they can appreciate what is happening, but are asked not to assist their child during lessons unless invited to do so, as the children are being taught to be self reliant. Parents are asked to help by exposing the children to as much musical sound as possible, the use of music terminology, discussing and relating music in which they have shown interest.

<u>The Junior Course</u> : This special program is for four to five year old children, teaching music fundamentals with emphasis on ear training. The ideal starting age is at the time of the fourth birthday, although a child of five may be enrolled. The class meets for one hour each week for a total of 84 class sessions (42 per year) for two years.

<u>The Music Prep Course</u> : This course is designed for six, seven and eight year olds who are too old to be eligible for the Junior Course. Consisting of 42 class sessions for one year, the Music Prep Course gives exposure to basic principles of music, with greater stress on rhythm and reading and less emphasis on ear training.

<u>The Junior Extension Course</u> : This course is limited to graduates of the Junior Course and as the name implies is an extension of the knowledge acquired in the Junior Course. It involves more advanced coverage of the music fundamentals and aims at greater refinement of these components through more ensemble activities.

The results of Junior Course training begin to manifest itself in the Junior Extension Course. Therefore graduates of the Junior Course should be encouraged to become involved in this continuation of the program in order to receive the full benefit of Yamaha's offering. The Junior Extension Course lasts for one year, and the class session time may on occasions exceed the usual one hour period to which Junior classes are limited. At the completion of the two year Junior Course the teacher has attempted to have the children proficient in the following:

(1) Read in both treble and bass clefs, hopefully to two leger lines outside each (for a four octave range).

(2) Develop an acute sense of Relative Pitch, so as to recognise the sounds of intervals and chords for duplication in either singing or keyboard playing.

(3) Understand tonality through four sharps and four flats, both major and minor and read (elementary level) in these keys.

(4) Understand the essential make up of the keyboard and its application. Certain fundamental cadences in these keys should be able to be played, and printed music should be able to be related to the keyboard.

(5) Harmonise simple melody patterns, using primary triads and their substitutes (especially super-tonic and sub-mediant) chiefly in major keys.

(6) Sing and play (at keyboard) in canon or duet.

(7) Respond accurately in imitative rhythm and create original rhythm answers.

(8) Be creative in melody as well as rhythm.

(9) Acquire a grasp of the feeling of actually composing.

(10) Take part in successful ensemble work, both singing and playing.
The section above is from the Yamaha Method Parents Handbook)

The Yamaha method based on the fundamental belief as stated in the first paragraph is sound for the development of Relative Pitch. It is my opinion it would be greatly improved by some attention to the Absolute Pitch learning that is possible from birth up until approximately six years but more especially the first three years of life. Work at this age would require daily sessions of ten to fifteen minutes. This I suggest could be organised Suzuki style by the mother being trained with the child once a week in order that she can carry out the training on other days. 'Little but often' is a must at this stage.

The Jacques-Dalcroze Eurhythmics

Eurhythmics was developed at the beginning of this century in an attempt to "bring into play, simultaneously, all human faculties" (Frank Martin, 1953). It is a complement to various forms of teaching and not a substitute. It is born out of Solfeggio with music as its primary driving force. The first concern being not to make music but to listen to it. The ear must be developed by practising solfeggio, hearing in all forms must be cultivated, i.e. intonation, intensity, rhythm. Without musical hearing, says Martin, we would revert to a sort of primitive state where only the rhythm as such counts, joined to bodily movement. It requires: (1) Attentiveness; (2) Intelligence; (3) Sensitivity. Following these three the body goes into action.

To summarise, the meaning of Eurhythmics is firstly to create in young people a genuine rhythmic sensitivity, by making them feel the musical rhythm in their body which, with its muscular system, is the very seat of all rhythmic movement.

Secondly, as this rhythm is by nature musical, the meaning of eurhythmics is to teach to hear and to feel music: the body work must be accompanied by an advanced study of solfeggio under two forms: dictation and sung solfeggio.

Finally, by its power of bringing into play simultaneously various faculties of man, i.e. attentiveness, intelligence, quickness of mind, sensitivity and bodily movement, eurhythmics helps create a harmonious synthesis of these faculties which finds expression in a sensation of happiness and fullness. (Martin, 1953). It is in the eurhythmics lesson that we can build "a bridge between body and mind" (Du Toit, 1976).

Jacques-Dalcroze's "harmonisation" between perception and action (sensory motor education) between feelings and bodily life (psycho-somatic education) between will and ability (education towards liberation) and between persons (social education) (Porle, 1976) illustrates that eurhythmics is a musical method of general education.

A study of the work on Human Motor Performance carried out by Ronald Marteniuk, University of Waterloo, Ontario, Canada, shows the importance of any method including the sensory motor system for learning.

COMMENTS ON THE TIME-TABLE AND CURRICULUM

Comments on the Time-Table

Music lessons should be held as early in the morning as possible, preferably the first lesson so as to take advantage of the child's extra acuity of hearing at this time. Lessons should begin with a ten minute session gradually extending to twenty minutes, that is, the maximum time before auditory fatigue sets in following concentrated auditory training. There should be such a lesson each day throughout the Primary School stage. Nursery Schools should have similar daily sessions but these would probably not develop beyond ten minute sessions.

Since most schools without the 'integrated day' seem to operate on a 35 or 40 minute lesson, it should be possible to cross this subject with another subject requiring short, daily sessions. (For this purpose I have found that second language learning was a suitable subject.) The ideal allocation of time for music in the Primary and Nursery Schools should also include a longer (afternoon?) session in a larger space which would permit the use of the Orff type instruments, free movement and creative music projects, without noise becoming an inhibiting factor.

Handicraft lessons could make simple instruments, the tuning of which would contribute to the need to attract the attention and interest of the child to the exactness of pitch. At the Secondary stage the ideal time-table requirements would vary according to the level of music literacy. For those coming from a Primary School where adequate aural training had taken place, this would mean a continuation of the short daily twenty minute sessions for four days a week, until puberty. This could then be changed to a minimum of two forty minute lessons each week. For the musically non-literate child from a Secondary School, a weekly session of forty to sixty minutes would be better in order to permit projects such as the making of instruments, building of programmes, etc. If, however, the band method is used, then again the shorter daily sessions for tuition should be operated with one longer session for ensemble playing.

Comments on the Curriculum

Pitch learning should be the priority of the pre-puberty years - the methods of Justine Ward, Curwen, Kodaly, Orff, Suzuki and Yamaha can all be utilised in this work, with the choice probably depending more on the equipment available, than for any other reason. In my opinion no one method alone caters for the child's needs completely, and so all should be studied in order that the selection of methods can be based, adapted, or added to, according to the needs of each situation.

Justine Ward's suggestions regarding the vocal development of children coupled with the Curwen and Kodaly methods would produce accurate sight singing with a pleasing and natural tone, providing notice is taken of some of the early remarks about rhythmic training. To this work would need to be added some attention to Absolute Pitch learning which could be done using either the Suzuki method or my suggested adaption of the Orff method. As the lesson length is gradually increased some work on Piano Class Teaching or the Yamaha method could be included, with the Orff method and Creative Music projects being used in the longer afternoon sessions. Musical instruments can be made by the pupils if there is insufficient for all to participate, and the tuning of these instruments can be a useful, additional method of pitch learning. With the use of a pitchmeter the full range of bamboo pipes (S.A.T.B.) can be made plus xylophones. (James, M., 1972)

Suggestions for the Secondary Schools Syllabus

(a) Further work can be carried out on the making of instruments as mentioned previously.

(b) Brass Band work can be introduced as all brass instruments may be taught in groups, using the same fingering. Instruments can be hired for a weekly fee from most manufacturers and eventually, after a period of two years and the payment of a nominal fee, can become the property of the school; several children can share the same instrument providing each child has his or her own mouthpiece.

(c) Piano classes based on the description of the procedure mentioned in the section 'Instrumental Influence' and the Yamaha method.

(d) A School Radio Station can be established - literary works can be arranged for broadcasting using experimentation with sounds for essential sound effects.

Where there has been an adequate music education at the primary stage, vocal work can be continued providing all understand when the older boy is finding it difficult to place his voice; in this way he is not made an object of ridicule. It is unrealistic however, to expect to be able to introduce a programme of music education based on the voice where there has been no early training.

The Open Plan

As with most other approaches and methodologies, the Open Plan approach also needs selective use guided by basic common sense. Young children allowed unrestricted use of wide spaces without a clearly defined area as their base become insecure. Define their base and make it secure and they gain confidence; a gradual enlargement of their world is needed. A poorly designed Open Plan System does not allow for this. Moveable screens and partitions could be the solution as these permit large spaces for some activities and yet allow for the necessary 'places of refuge' for others.

The noise factor is important. Often there is no consideration of this as the screens are not capable of sound-proofing and floor surfaces are usually non-noise absorbant. Since pitch learning requires listening to the softest possible sounds, discrimination between sounds and the evoking of a response to a sound, it is clear that Open Planning must include facilities for such activities as pitch learning. The experiments using pink noise as a masking background noise presently being carried out at the National Physical Research Laboratory are horrifying in their implications for education. All disciplines, dependent for their very being on pitch, intensity and duration discrimination will be damaged, and since these include speech, reading, spelling, and any form of verbal communication and expression, it becomes doubtful whether education can exist in such a background. It is also interesting to note the difference between what children prefer and what adults (with their heads buried in the text books of behavioural theory) think they prefer.

Observe small children in a setting with easily moved screens. The screens are soon moved to divide the space into little cubicles for some activities, or, a larger play area is made by moving the screens further back or to one side. Measure the times however that they choose the restricted spaces and one finds that these far outnumber the choice of wider spaces. As the children grow older their choice of larger spaces increases resulting in a reduction of the previously more favoured restricted spaces.

The Integrated Day

Whilst most people accept that the Integrated Day is a must at Nursery and Primary school levels, once again the approach often suffers from an unsuitable medium of integration, lack of organising ability and 'know how' on the part of the teacher and an inability to determine which areas of the curriculum requires an authoritarian approach and which an exploratory approach. The majority of teachers have accepted the mother-tongue as being the integrator and support the Bullock Report* that all teachers are language development teachers. Unfortunately the implications of this are often not considered in depth. This is made very clear by the lack of pre-language training and preparation that can result from the use of the visual and auditory arts.

Is there a single subject that could not be approached via Music and Art at the Nursery and Primary School level? What better integrator could there be? At least the basic visual and auditory discrimination and learning would be developed, thus making it possible for all subjects to be developed according to their potential.

(* H.M.S.O., 1975)

SECTION VI

CONCLUSION

A study of the summaries of each section of this thesis shows how age directly controls pitch learning and the procedures by which it is learnt. It controls not only whether any pitch is learnt at all but also the accuracy, nature and quality of that pitch which is learnt, as these are dependent on the influencing factors present during the optimum age. Once outside this age they have little influence on pitch learning but are useful for stimulating recall and for reinforcement.

It is important to remember that the nearer the age to the optimum age for pitch learning the greater is the need for constant reinforcement, since these are the years of greatest plasticity of the brain when behaviour is most easily modified. With this in mind, I have therefore prepared a list of conclusions for teachers, with some suggestions to assist them in putting these conclusions into practice.

Some Conclusions for Teachers : The child does not learn to hear, he learns to comprehend what he hears. The survival hearing with which he is born is concerned with acuity of hearing for individual pitched sounds (Absolute Pitch). The degree of learning of these sounds achieved depends on the following:

1. Intact hearing mechanism operating at maximum efficiency during the optimum years, i.e. the first six years.
2. Training and Material appropriate to the stage of learning, i.e. concerned with individual sounds; availability of sufficient auditory stimulus during these years, with sufficient evoking of response during this optimum period by the provision of

sounds that are important and meaningful to the child.

3. Consideration of the 'Sufficiently Often - sufficiently Loudly' maxim, remembering that approximately 305 listenings per hour for as long as a year were observed before learning took place, even during the optimum years.
4. The age factor, remembering that it is the hearing levels during these early years that affects Auditory Memory acquisition (not the hearing level at the time of testing, since learning cannot take place before perception), and that Auditory Memory acquisition appears to be strictly age controlled with the first learning of pitch on the decline from five years of age, and is impossible after puberty.
5. An undeveloped Auditory Memory affects the ability to sing in tune, develop a sense of Relative Pitch, Reading, Writing and Spelling. Quite small hearing losses including the variable losses during colds, tonsil and respiratory infections, during the first six years of life can prevent an Auditory Memory from developing in addition to speech damage.
6. Minimal Hearing Losses result in sound losing its impact. Day-dreaming and lack of concentration often result from the fact that these children can hear when spoken to individually, but allow sound to go 'over their head' when in a group. There is also a tendency for these children to become unresponsive and lack stimulation, with their speaking voice appearing flat and without variation of tone.
7. Hearing levels during the early years appears also to be related to success on certain instruments, i.e. a child with a hearing loss of more than 30 dB for the high frequencies,

but no more than 10 dB for the lower frequencies would be wiser to choose a Cello than a Violin. The reverse is also true. Acquired hearing losses once an Auditory Memory is acquired do not affect intonation until the loss is severe enough to prevent matching of intonation in ensemble playing.

8. Auditory fatigue affects pitch learning. It sets in after approximately ten minutes, more quickly for the higher frequencies and appears to be a function of Frequency, Intensity and Duration. Variation of all three in pitch training sessions is therefore important. Auditory discrimination is more acute in the young child in the early morning. Pitch Training should therefore be carried out in the early morning for short periods and should include work on both aspects of pitch learning, i.e.

    (a) The exact pitch of individual sounds - Absolute Pitch.

    (b) The relationship between sounds - Relative Pitch.

   The first aspect suffers as the result of fatigue more quickly, usually after ten minutes, but work on the second can continue for longer since this requires less acuity of hearing and must involve the use of other cues, particularly the visual cue. Approximately 50% less hearing is required for the development of Relative Pitch. This work can usefully continue for a further ten minutes. Extremes of Auditory Fatigue must be avoided since there is a definite change of pitch perceived by the fatigued ear. What is perceived is what is learnt.

9. Pitch Learning is better for long tones as there is a build up in response of the brain to the auditory stimulus. The pitch sensation needs a certain amount of time to reach its maximum, so duration factor in pitch learning is important. Audiometry shows

a definite shift in threshold for long tones over short tones.

10. Room Acoustics must be studied in order to ensure that Pitch is not masked by background noise or lost through absorption or distorted by reverberation. The decay of tone in air should also be considered when deciding on the size of rooms used for pitch training.

11. Like all forms of learning a Feedback System must be established in Pitch Learning by sufficient experience followed by practice as even imitation requires a kinaesthetic memory. Pitch Learning requires a great deal of repetition over as long as a year to establish the foundation on which to build and develop and even then continuous reinforcement is necessary. Discovery methods, Creative Music Activities, Exploration of sounds, etc., are all useful for evoking interest and response but on their own do not provide sufficient repetitive drilling needed for the learning of pitch.

12. Routine Pure Tone Audiometry is important for all children during the first six years of life since there is much equipment available nowadays to amplify deficient frequencies and make first learning possible and thus develop an Auditory Memory among children with reduced hearing levels. Once learnt, considerably less hearing is required for the recognition of familiar sounds.

13. Relative Pitch is concerned with memory of relationships as against the memory of individual sounds as in Absolute Pitch. Relative Pitch therefore requires a second stimulus to be used in the conditioning process. The visual cue has proved to be the most useful and efficient second stimulus but others are

possible. The use of several cues increases learning potential as the greater number of Sensory Systems involved in any one piece of learning, the greater the learning. Spatial, Kinaesthetic and Tactual Cues should therefore be used to reinforce the Visual and Auditory Cues whenever possible.

14. Auditory Memory is concerned with Auditory Span (Temporal) as well as Pitch. Span however is affected by the degree of Absolute Pitch learning.
15. Instrumental experience at the Piano affects the learning of Pitch more than any other instrument. The Piano used as a point of reference in the Music Class produces better and quicker pitch learning.
16. Tone Deafness in the absence of clinical defect should not exist. This apparent condition is removed by training providing it is carried out in the pre-puberty years and permits sufficient practice to establish the necessary feedback system. It is concerned with the establishment of an Auditory and Kinaesthetic Memory. At worst, it is a failure to learn and rarely a form of deafness.
17. The ability to learn through hearing gathers momentum with training, providing the hearing level is adequate as is shown by the work of E. Whetnell, Suzuki, Curwen and Kodaly.
18. Individual work is better in the Kindergarten than group work in pitch learning, with Interval Singing more accurate than scale-wise passages.
19. Speech is a unique mixture of Absolute and Relative Pitch learning. It follows therefore that the acquisition of relative pitch is largely second learning for those having acquired speech,

which is reflected in the success of the so-called 'mother tongue' approaches to music education, i.e. Suzuki, Kodaly and Curwen.

20. Intelligence can impede the learning of pitch, because the threshold of boredom is reached more slowly among the less able, making the repetitive aspect of pitch learning more possible. Slight amplification produced a greater response among the lower ability group.
21. Multivitamins improved concentration and energy which as a result increased learning. Colds and Respiratory Infections affect pitch learning because of the reduced hearing levels and the depression of pitch by a semitone. Several such attacks during the first six years of life can permanently affect learning by failing to establish an Auditory Memory.
22. After six months of training, periods of rest can beneficially affect pitch learning, i.e. a school holiday after the third term of training appears to result in pitch learning becoming more established during the break. Prior to this there is a regression during school holidays.
23. Falling Intervals were learnt more quickly than rising intervals.
24. Hearing Development is approximately three years in advance of Vocalising, what the child expresses vocally at six is what he heard at three. The auditory range of perception is far greater than the vocal range. Auditory Training must therefore not be restricted to the vocal range of the child.
25. Tone is perceived as louder than non-tonal sound. Children should be trained to perceive at the softest level in order to develop critical listening, as Dynamics affect Pitch Learning.

In Hungary it was noticed that greater sensitivity developed as a result of attention to Dynamics than to intonation.

26. Complex Rhythmic work impedes Pitch Learning. Rhythmic training should therefore be carried out separately from melodic work, preferably on an instrument to prevent careless intonation; Orff type instruments are very suitable for this work in the Primary classroom. Pitch learning must be the priority of the Primary School years since this is so age controlled, and appears to vanish at the onset of puberty, whereas rhythmic work does not show any regression until after eighteen years of age.

27. Vocal experience greatly aids pitch learning.

28. Training methods and materials should take into consideration the many stages of Pitch Learning. There is little chance of learning Absolute Pitch after approximately five years of age, but plenty of effort and work with the use of visual and other cues will develop a good Relative Pitch. Even with Relative Pitch the time is limited until the onset of puberty, after which first learning is not possible. After the onset of puberty reinforcement becomes the important purpose of Pitch Training since 'forgetting' is still possible to varying degrees without this.

29. Constant reinforcement of pitch is necessary.

30. The vocal quality of children trained solely via the tuned percussion instruments without the use of the piano as a point of reference has been observed as being very poor. This is probably due to the lack of upper harmonics in the tones produced by many of these instruments.

Some Suggestions for Teachers arising from these Conclusions and Summaries

1. Start at the softest level by games drawing attention to faint sounds of the environment, i.e. get the children to list every sound even the faintest that they can hear, with their eyes closed to assist concentration. Starting with this every day attracts the child to sound and develops listening and self discipline, a skill which has become neglected with the decrease in authoritarian teaching requiring the child to listen.
2. Having attracted the child's attention begin with the scale of C Major. For children over the age of six it appears to be a waste of time not to immediately introduce a visual cue (a substitute one if teaching the blind), supported by as many others as possible when introducing pitch learning as at this stage it is mainly Relative Pitch which can be developed and this requires such cues. A ladder drawn as in the programme is a suitable initial visual cue since it introduces by implication:

   (a) The nature and purpose of the scale.

   (b) The movable nature.

   (c) The spatial element.

   and will have already been met and possibly used in the home. Cardboard ladders can be made, the rungs labelled and the children given practice in climbing up and down singing softly or listening. With young children I found drawing a ladder on the floor and hopping etc. up and down or jumping for intervals all assisted; games were then played based on this exercise. Interval work has greater beneficial effects on auditory ability than scale-wise work.

3. Insist on soft singing with the instrumental sample (I found the piano the most effective as long as it was used as a point of reference only and undue dependence was not permitted) being heard above the voice. Train the children to stop singing and just listen, and mouth the sound as soon as they think they are wrong. This encourages critical listening without loss of confidence, the mouthing appears to encourage the learning of pitch. Allow the children to 'find the notes' on the piano for themselves, in order to tune their voice. Insist that such notes found are played very softly.
4. Do not be afraid of the critics of 'drilling' methods in pitch teaching; it is an essential requirement and it should be realised that many children fail to speak merely because of the lack of repetition. To learn the pitch of the intervals contained in the diatonic scale takes approximately one academic year with very many repetitions daily for five days a week, albeit carried out in a variety of ways.
5. Do not spend time testing during the first year - spend all the time and energy available on learning, but taking care to invent different approaches to prevent boredom and to always evoke response. Vocal response is essential to learning - mere so called listening at this stage, is usually a day-dreaming session, unless vocal response is insisted upon or some other activity is designed requiring the child to listen, before it responds.
6. In the early part of the day the child's hearing is most acute and so ideally music lessons should be a first activity of the day when possible, auditory fatigue sets in after about twenty

minutes in the very young child and forty minutes in the older child when the hearing is not quite so acute. Singing with a good tone requires greater relaxation. This is more easily achieved when the child is a little tired, but pitch is affected slightly by physical exercise and so it is not an appropriate activity after games. Over-tiredness and shortage of oxygen cause flat singing. The ideal time of the day for singing (tonewise) I have found is the late afternoon in a warm but not stuffy atmosphere. Altitude tends to sharpen pitch, coastal regions flatten pitch so extra attention is needed in the appropriate areas. Avoid singing immediately after a meal, but on the other hand a child cannot sing if it is hungry.

7. Traditional notation should be introduced as soon as the child copes easily with the ladder. This provides an excuse for revision of sounds; the procedure described in the training programme was found to be the most satisfactory for all levels of ability and age.

8. As soon as it is appropriate, plenty of writing and drawing of notation and tonic solfa should be done. This reinforces learning and defines it accurately.

9. Pitch Memory can only be acquired during the pre-puberty years - time is limited and so should be spent on this priority. Literacy cannot be gained without first building on auditory memory - without literacy the human organisation of sounds to make music cannot be fully developed. All activities at this stage therefore should be geared to pitch learning.

10. Rhythmic and Pitch Training must be carried out separately in order to develop the one without damaging the other since Pitch

Training requires minimum durations before a definite sense of pitch is experienced, and pitch itself varies according to intensity and duration, making it unsafe to introduce complicated rhythmic patterns during the age of extreme sensitivity for pitch. The prolonged sessions of loud rhythmic clapping unrelated to music however, that one sometimes finds in Hungary appear to do much damage to sensitivity of tone and intonation. I personally have found the tapping of rhythm to music lightly with insistence on phrasing and in the use of the Orff Instruments providing banging was not allowed, to adequately develop the rhythmical sense without damage to sensitivity of pitch or tone.

11. When the stage is reached that the children can sight sing a diatonic interval or phrase accurately, fluently and critically, then duration can be introduced providing that it does not include complex rhythmic patterns and is expressed as part of the same activity - hence the adaptation of the tonic solfa mentioned in the programme, i.e. doh-oh = 𝅗𝅥 and doh-oh-oh = 𝅗𝅥. This encourages a line in the singing voice, providing care is taken on a progressively forward instead of backward placing of each vowel.

12. I have found that to introduce the minor key before the fourth term of training by which time the work in the diatonic key is fluent and accurate retards the development of fluency, security and confidence in pitch learning. The minor keys appear to be less tangible to the child. It was interesting to note that representation of keys in the visual arts brought paintings of highly imaginary scenes with ephemeral pastel shades, whereas the major key brought more clearly defined, definite pictures, with brighter and bolder colours.

13. I found that a simple explanation of learning through one's hearing and the need for much practice and careful listening always produced much greater co-operation and effort, from all children from the age of eight upwards.

14. If the child is under six, varying degrees of Absolute Pitch learning are possible and consequently conservation is not. At this stage therefore the need is to:

    (a) Attract attention to individual sounds at the softest level.

    (b) Introduce a variety of pitches - again at the softest level, but always with meaning and in a pleasant manner. This can be done with the use of pitched toys.

    (c) Singing games to evoke response and encourage listening and gradually lead to conservation. Formal singing lessons are not appropriate, owing to the unreliability of vocal cord response due to the spasmodic growth spurts of the vocal folds, but plenty of opportunities for vocal experiments are needed.

    (d) Constantly realise that the emphasis is on evoked response to <u>listening</u> in any way found acceptable and pleasurable to the children, and that the vocalisation at this stage is not a measure of the state of ability to listen, since listening is approximately three years in advance of vocalisation and must be developed separately since hearing acuity for individual high pitched sounds is on the decline by the age of five years. Listening training must not therefore be postponed until vocal maturity is reached.

Remembering that Lowe found that a child needed to hear a new word approximately 300 times per hour before learning it, will also help to remind one of the slowness of first learning and the need for constant repetition of sounds which must be within the hearing range and level of the individual if learning is to take place. Remember also that the acuity of hearing at this stage is for individual, unrelated pitched sounds. All children should have their hearing range and level checked.

15. Remember that for learning, sounds must be within the hearing range of the individual for whom it is intended, and that a sense remaining unused becomes atrophied. The limited vocal range of the child makes it impossible to explore vocally the field range of hearing of the child - here then is a further use for the Orff type instrument or any improvised alternatives for fulfilling the need to explore critically before organising.

16. The vocal range of the child is limited according to age and as it is not the same as the hearing range, it must be catered for separately. Many teachers choose vocal material that is too highly pitched because they have been told of the child's hearing acuity of high pitched sounds. A study of the child's development in pitch singing from kindergarten to puberty referred to earlier, shows the vocal range of songs that is needed for each age group.

17. Sarah Munro and many teachers of the deaf, have found that children playing a note at the piano for themselves, appear to perceive the sound at a louder level than their Pure Tone Audiogram would suggest they could receive it. I have noticed that many children sing the note more easily in tune when they play it for themselves. It is important to realise that the singing of scalewise ascending passages does not necessarily

involve auditory work as it is possible to slide up vocally without checking each step. The singing of intervals however is impossible without listening, hence the greater pitch learning that results from this. Any scale requiring the singing of intervals such as the Pentatonic Scale would therefore improve the accuracy of pitch learning of the pre-puberty child.

The implications arising from these summaries and conclusions are many. When they are studied in conjunction with the outline in brief of the major works and research being done on the language acquisition of the child, then it is possible to list the priorities amongst these implications. The most important in my opinion would appear to be:

(1) Music Education must give pitch learning the priority it demands as a basic skill contributing to the evolution of the species. Without pitch learning there can be no language, and without language there can be little development.

(2) The procedures and methods by which pitch is most easily learnt, together with the optimum environmental conditions should be studied and the time table, syllabus and teaching methodology used, amended accordingly. Those responsible for teacher training should take note of the age controlling aspect in order that the teachers, having the children at the age when pitch is most easily learnt, that is, the Nursery and Primary School teachers, are trained:

   (a) To be able to do the necessary teaching.

   (b) To realise the importance of pitch learning.

The training of these teachers should fully explore the auditory aspect of reading, stressing that the development of auditory skills is dependent on the child's repertoire of 'learnt sounds', i.e. Nursery Rhymes, Folk Songs, Words, etc., acquired during the first six years of life and its need for auditory discrimination during these optimum years. Unless a child's environment requires it to discriminate between sounds, it will not learn to do so, even if the organ of pitch discrimination (the cochlea) is functioning normally. By the time children arrive at school, particularly when this is delayed to six years of age, it is already very late for essential pre-reading auditory training, consequently this must receive urgent attention immediately at school, although to achieve maximum success pre-school auditory training is essential. The decrease in Authoritarian teaching in schools requiring the child to listen, makes auditory training all the more essential.

Musical games in the Nursery School should be carried out by a suitably trained teacher having an understanding of the audiological functioning of the child. These should cater for pitch discrimination, analysis of complex sounds into single sounds, listening for the softest sounds available, recognition of varying degrees of soft and loud and durations, responding to simple rhythmical patterns and identifying fixed pitch sounds. Eventually these should be related to symbols.

These games would give the pre-reading training required and effectively and accurately screen all aspects of the child's hearing, i.e. Conductive, Perceptual and Central, in a nontraumatic play situation.

A realisation that disability in reading is very often of auditory origin as is shown in the article 'Dyslexia and Music', (Byrd, 1976), emphasises the need for the acceptance of the great responsibility by Music Educationalists to provide adequate auditory training in the methodologies - at the moment most pre-reading training is purely visual.

(3) Parents should be educated in simple ways of providing adequate auditory training under the most optimum environmental conditions for the pre-school child, since it would appear that the greatest learning of pitch takes place during the first three years of life. This training is most likely to receive the chance of becoming effective if it is <u>not</u> called early musical training, but rather 'early language development' or 'pre-reading training'. In this way the subject is less likely to be dismissed as unimportant.

(4) The general public, particularly the medical and paramedical professions must be made aware of the part played by pitch memory in language development, in order that learning difficulties may be readily identified and so enable suitable therapy to be carried out. At the moment many learning disorders arising from a lack of pitch memory are caused solely by the lack of early opportunities. These are unecessarily being labelled as 'central disorders.

It is further suggested that routine Audiometric Tests should include tests of Pitch Discrimination and Memory, and that the training of Music Educationalists must include a course in the basic audiological functioning of the child. Teachers must be made aware of what music education can contribute to the development of the whole child. Some training in the use of musical activities in the classroom as a means of screening the young child's hearing in a relaxed, non-clinical setting, should also be included.

Finally, it is to be hoped that this thesis will direct the attention of Educational Planners to all the consequences of failing to provide an adequate Music Education at the Nursery and Primary School stages. These include the state of compromise that exists in Secondary Schools where pupils are beyond the optimum age for the first learning of pitch. Since pitch memory is a basic component of music literacy, the Secondary Schools are therefore prevented, in many cases, from developing the subject.

Pupils and Teachers alike are faced with a near impossible situation, further aggravated by a lack of understanding of the aspects of Music Education which could still be developed after puberty.

The choice for the teacher often seems to lie between inventing time occupying activities making little musical demands on the pupils, or accepting the inevitable indiscipline and associated chaos in the classroom.

The solution is to base the Curriculum, Syllabus and Methodologies of Music Education on the audiological functioning of the child and thus make Music Education a reality.

APPENDIX

THE TRAINING PROGRAMME DEVISED DURING TEN YEARS WORK IN A RESIDENTIAL SCHOOL

This began with a ten-minute session each morning, which increased gradually to twenty minutes. The same procedure was used daily.

1. We started from silence, the children closing their eyes and listening to all the sounds around them and then being asked to name everything they could hear, even the faintest sound in the distance. Throughout the training emphasis was always placed on hearing at the softest level, since this was observed to bring about the greatest concentration.

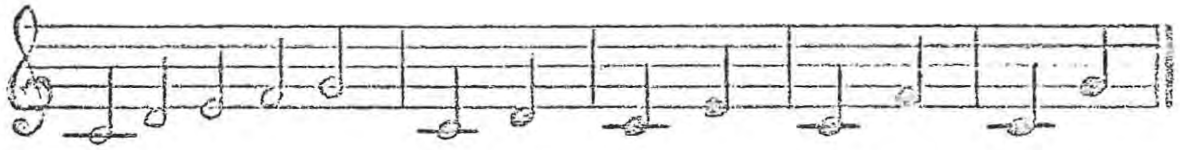
2. The major scale was played at the piano, starting on middle C, and played very softly - the children were told to close their eyes and just listen, pretending the sound came from their mouth.

3. I repeated the scale and the children hummed the scale very softly, but stopped if they did not think they were making the right sound - they were told to just listen and try to join in when they thought they could.

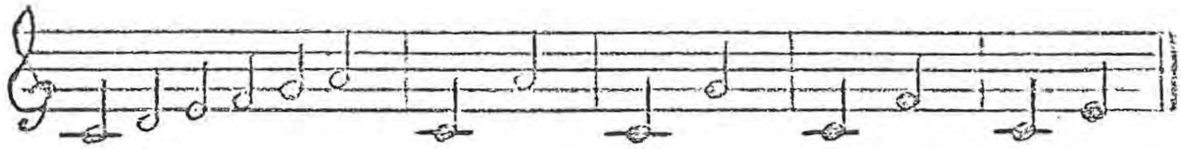
4. The children sang softly to 'lah', with instructions to make sure they could hear the piano more loudly than their own voice. Always the instructions were to sing softer than the instrument, and to stop singing when it sounded wrong, thus bringing about self criticism, the beginning of discrimination.

I then played each note twice, then three times and lastly four times. For those children who could not manage to sing in tune immediately, and this was often the majority, it usually took two weeks of daily practice, before they were capable of doing this, and often longer on individual notes. The stages of learning to sing in tune were as follows:

<u>Stage 1</u> - usually very quickly reached.



<u>Stage 2</u> - more practice needed to sing A than was needed for the whole of Stage 1.



<u>Stage 3</u>.

(You will notice that B was pitched when approached by leap but not by step.)

The stepwise approach to B required much extra practice vocally in spite of the fact that aurally B was one of the first to be remembered.

There was no attempt to test memory for the scale, as I had previously found that testing introduced an element of insecurity which impeded learning, whereas emphasis on listening initially to the matching sound source produced more accurate learning of pitch.

At first, notation was not introduced, but cardboard ladders were drawn and cut out, and as I either played the scale or the children sang while I played, so they walked up the ladder with their fingers.

When the children could sing the scale in tune, then staff notation was introduced, initially because it was a means of giving plentry of practice in learning the sounds of the same notes in different ways, in order to prevent boredom.

The children started with blank sheets of drawing paper, they were reminded of the usual alphabet, i.e. A B C etc., and then told that in music they were lucky, because it only went up to G, before starting all over again.

We then went to the piano and chanted up the piano from A - they then picked out the second G on the piano as the first line to be drawn etc., and so we built up the Great Stave, line at a time, with children taking it in turns to find the note on the piano. When we had all eleven lines we rubbed out the middle one to demonstrate the reason for the appearance of the Stave. There was much practice in drawing of Staves, simple games designed to learn the sound of notes played and the humming of notes as played and drawn by them on the Stave. This all helped to prevent boredom over the constant drilling with the scale.

The next step was to explain the need to have the Stave, albeit for present singing purposes we were only concerned with the Treble Stave. It was at this stage that the separate piano classes began.

By this time the children all knew the tonic solfa ladder, and would happily draw it from memory as they sung it softly, while I played it. We also chalked the ladder on the floor, so that we could climb up it, taking great care to know and to feel where the semitone steps were.

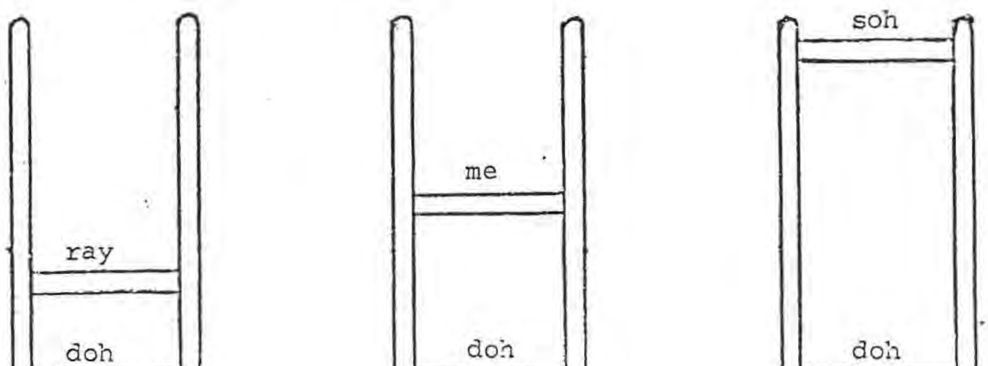
By this stage the daily sessions had been increased to twenty minutes. The procedure remained the same but greater attention was paid to intervals, i.e.

1. to listen

2. to hum

3. to sing the intervals to tonic solfa, but making sure that they could hear the piano above their voice.

As they listened or sung, so they jumped with their fingers up the ladder. This was done as a daily drill and to draw attention to the spatial element they practiced drawing the intervals, i.e.



They later learnt to count the interval to reinforce this and would immediately label the interval numberwise by counting all the rungs of the ladder, e.g. Doh-Ray = a second.

Extra practice in learning the sound was by writing on the Staff, followed by children coming to the piano and playing intervals for the children to draw. By the time they had all had their turn, much practice had been given in learning the sounds of the intervals yet without boredom being reached.

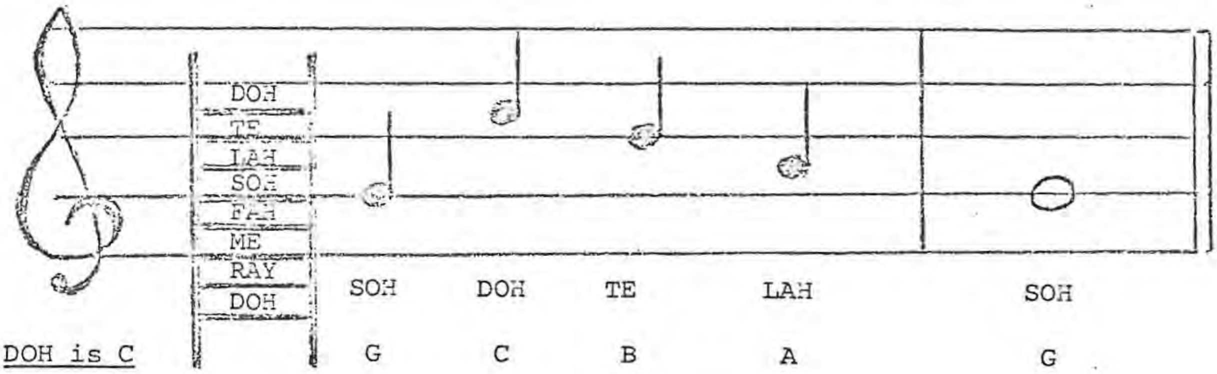
The next stage showed how the cardboard ladder could be picked up and placed on any line or space of the stave and although the letter names were different, the ladder remained the same. Key signatures were introduced as the signs showing which note to stand the first rung of the ladder on, and the daily drill of the scale and intervals was then increased to include most major scales. By this time the children could draw the intervals, number them, and draw the notation on the stave, and simple note and rhythmic values had been introduced. Note duration was always functional to ensure that rhythm could be expressed vocally alongside tonic solfa.
The drill then began to include duration of notes by an adaptation of the French Time-Name System.

doh as ♩ was sung as doh
doh as 𝅗𝅥 was sung as doh-oh
doh as 𝅗𝅥. was sung as doh-oh-oh
doh as 𝅝 was sung as doh-oh-oh-oh

and so on up the scale.

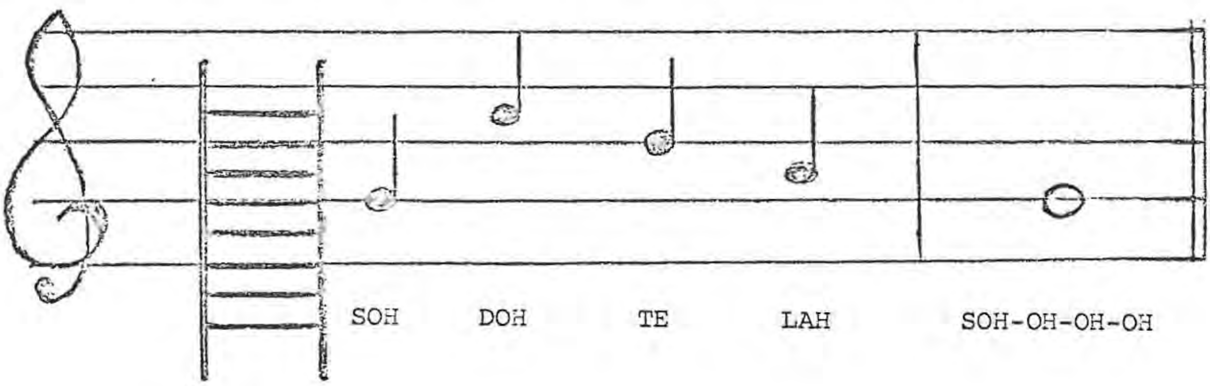
This had the added advantage of encouraging a line in singing without expecting the child to do two things at once, as is the case with other forms of rhythmic work superimposed on pitch work.

Following this stage came the sight singing of extracts of songs in addition to the daily drilling. When the children sight sang it correctly they then wrote it down in staff notation and completed the exercise by naming it with letters and a tonic solfa, e.g.



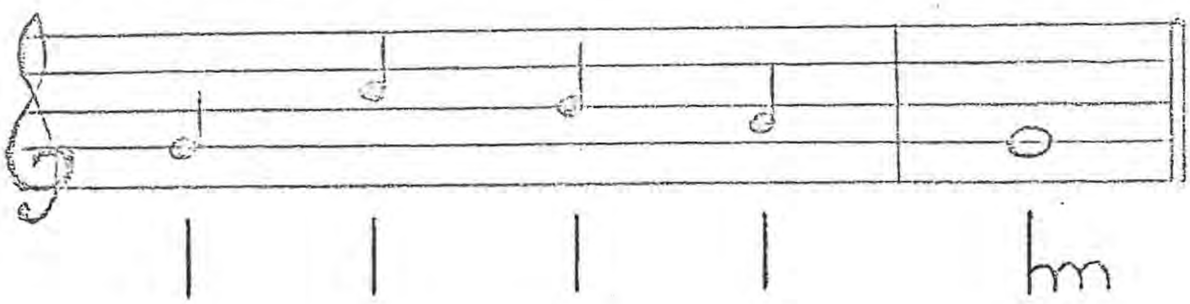
The ladder was always drawn in once the class had worked out where to place it.

Following this we began to work on songs. They first copied these out in notation, then worked out the tonic solfa, and then practised the song to tonic solfa until they could sing it from memory. Rhythm was expressed as doh-oh for , ray-ay, me-e, etc., with the result that it was now sung and written as:



The next stage was to introduce simple rhythmic shorthand into the daily practice, e.g.

It was now possible to write the exercise as:



From this stage it became possible to play the songs to the children while they wrote it down in notation, the excuse being to save time. The work was then checked for accuracy and the tonic solfa added. The children's work showed that their pitch learning followed their ability to sing in tune but with a considerable time-lag. What the children were able to sing in tune became the basis of their pitch memory providing they continued to practice this sufficiently. It appeared from the children's progress that a year's regular work was required for the establishment of a pitch memory.

At this point I became increasingly aware of signs that suggested that the ability to sing a scale in tune with a matched sample was not entirely an auditory ability but that it appeared to be very largely a kinaesthetic memory from the vocalising experience gained as the vocal cords were gradually stretched to climb up the scale and that in this way the upper note was often slightly flat when approached scalewise, whereas with training, when approached interval-wise thus preventing the gradual stretching process, the ability to pitch intervals took longer to learn but intonation was more accurate. Interval work quickly showed greater effect on the establishing of an auditory feedback since it was necessary to (a) receive much practice in exactly matching the vocal cords to the sound, stimulating reliance on auditory ability unaided by vocal experimentation from the gradual stretching of the vocal cords, and (b) receive much practice in experiencing vocally the placing of the interval - again unaided by gradual stretching.

I later found that many of the students whose intonation when singing was not good would usually manage scalewise passages and the trouble began when they had to sing intervals. Investigation showed that they relied entirely on vocalising experience and not auditory training and experience. This is apparently often the root cause in so-called Tone Deafness.

Copy of Questionnaire used when collecting information about the nature of the young child's response to sound.

Name: Date of Commencement of Record:

Address: Age at Commencement:

Sex:

<u>HISTORY</u>

Please list any known illnesses, defects and/or accidents in:

Mother's Family:

Father's Family:

List any problems that arose during Pregnancy:

Describe the birth:

<u>Keep Record of the following on separate paper in diary form</u>:

1) Describe the home life of every member of the family during the first two years of life, health, occupations, absence from home, frequent visitors, etc. Note <u>any</u> response from the baby to any of the above.

2) Health record of the baby.

Date	Source and Nature of Sound or anything that evokes a sound response from the child.	Child's Response	Any special conditions prevailing, e.g. Health

Please send each sheet to me as it is completed but bring the diary with you at your next monthly visit.

Age at onset of Blindness	Age at time of test	Total No. of Children Tested	No. with perfect pitch	No. who are tone deaf	No. who can sing in tune	Details of any Musical Instrument played, with age of commencement in brackets	No. with Relative Pitch	Details of any other handicap for those with Perfect Pitch
Birth								
1 yr								
2nd								
3								
4								
5								
6								
7								
8								
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21								

NOTES

Please put the number who are partially-sighted in brackets in these 3 cols.

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