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2.1 Introduction

Computer-based speech training has capabilities of offering the children immediate and meaningful visual feedback and might make it easier for the teacher to instruct and explain what is wrong and what is correct and through motivational and frequent training establish an intelligible production. In most schools for deaf children in Sweden, computer-based visual speech training has become a standard and valuable complement to the regular speech-training activities.

Hard of hearing have vocal organs which are normal and hence can produce speech. This is especially so if they have some language ability. That is, if a child has acquired deafness after having exposed to hearing the language. Hence the dictum "**deaf need not be dumb**". The reason that they may not be able to produce speech is because of the lack of auditory feedback, i.e., inability to hear what they have spoken and hence unable to correct what is spoken if it is incorrect.

- **Picture-Word-Ariculation test** may be used for an evaluation of the pronunciation errors. Exercises may be given to **correct the pronunciation errors**.

- Their dependency on **lip reading** sometimes leads to mis-pronunciation of speech sounds. For example, 'p', 'b' and 'm'. **Nasal indicator** may be used to make them aware of the production of nasals.

- Also, the hard of hearing often lack '**breath support**'. That is they are unable to speak for a long duration in a single breath and they have to take breaths often. Their breath support has to be improved.

- Further, a hard of hearing child tries to speak at a **very loud voice or shrill voice** since for the child itself they sound normal. In course of time this leads to **voice abuse** and possible damage of the vocal folds (the voice box). This can be prevented by a proper voice control.

- Some hard of hearing children speak with a **mono-tone pitch or dull voice**. They lack proper intonation and their voice will not be lively.

2.2 Objectives

This chapter investigates some conceivable reasons to the sometimes limited and varied progress reported from computer-based speech therapy/training. The goal of CBST systems is not to replace the human speech therapist, but to be a complement, by giving the user additional training. In order to be successful, it is hence important that the system employs training and feedback strategies that are compatible with those of the speech therapist. This is especially true for a system such as ARTUR, where an animated agent takes the role of a virtual tutor. A virtual tutor will not be able to incorporate all the knowledge and creativity of human teachers, but speech training sessions with a real therapist nevertheless provide an important role-model for a CBST system with a virtual tutor. Primary school speech training with human therapists mostly follows the steps found in the literature: elicit, automate, generalize and facilitate linguistic use.

2.2.1 Training schedules:

The length of the session ranges from twenty minutes to one hour, and the child must leave the ordinary school schedule, or come to the therapist after school has ended for the day. The therapist and child usually meet once a week, but depending on the child and its problems, they can meet from three times a week to once a month. When speech training begins, the therapist

assesses the deviations that the child has and based on this plans the training. There is no typical training session since it is adapted to the child and the uniqueness of his/her speech. However, one of the features that the sessions have in common is that they are always playful and full of variation. The therapist does not only spend time training the phonetic difficulties that the child has, but also uses the material at hand to help the child with its language development, which is often weakened. The therapist tries to relate to the child's daily life and reality in all the training exercises, and to further develop the language that the child already possesses. If possible, the child is trained in discriminating speech sounds and to listen to its own utterances. Many of the respondents talked about awareness, to enhance the awareness of the world of sounds, awareness of breathing, awareness of the language etc. The therapist often begins with the speech sounds that the child already masters and from these makes the child aware of the deviant speech sounds. The techniques that the therapist uses are multimodal; enhancing the learning process with the help of vision, touch and hearing if possible. When the child becomes more mature, the therapist and child together analyze in a more theoretical way what happens with the articulators during speech production.

2.1 Computer based training aids/equipment for management of speech (Dr. Speech, Vaghmi, and Speech Viewer)

Computer-aided speech training presents visual feedback of distinctive contrasts that are not visible via speech reading and consequently difficult to produce correctly. There is a wide consensus that computer-based speech training (CBST) systems are useful tools in speech training. However, they are not suitable for all the needed exercises and a major drawback is that they usually require help from educated personnel. CBST systems are today widely used in speech training for children with a hearing or speech impairment. Examples of such commercially available systems are Dr Speech, Speech viewer, Vaghmi, etc.

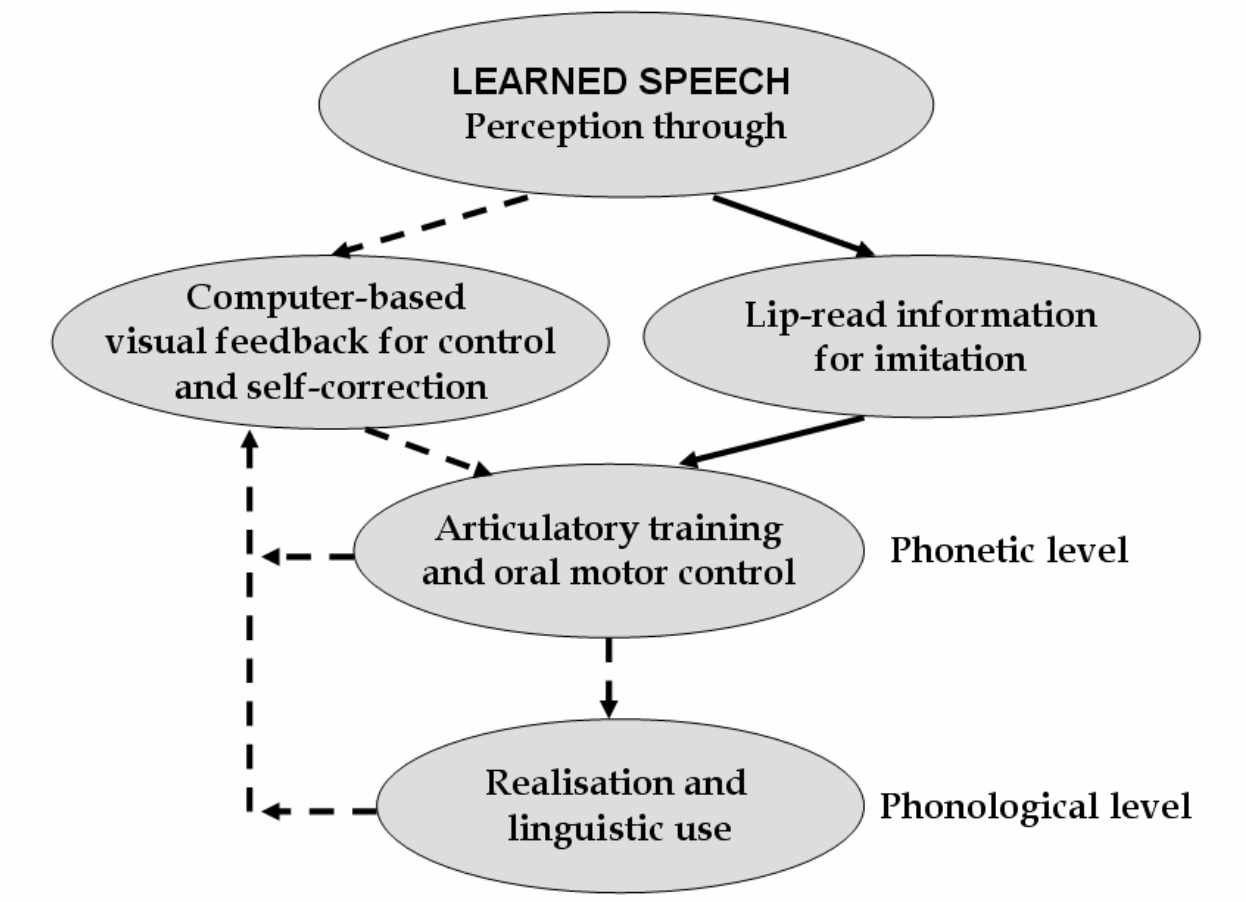


Figure :Assistance of computer-based visual feedback in profoundly hearing-impaired children's speech development.

Some of the computer assisted softwares are as follows:

Dr Speech: is clinical software which provides valuable assistance during assessment and treatment of voice and speech disorders in children with hearing impairment. Demographic information, such as names, address, number of visits, types of disorders, progress reports, insurance claim, etc. is easy to display. When such clinical software is installed in a laptop computer, it provides clinicians with a "portable clinical voice laboratory" equipped with powerful clinical tools that easily can be carried from one treatment location to another. Today's practitioners can benefit from the use of clinical software that has been adapted to the needs of clinicians.

It uses voice-activated game-like tool to provide real-time reinforcement of a client's attempts to produce changes in pitch, loudness, voiced/unvoiced phonation, voicing onset, maximum phonation time, sound and vowel tracking. Children, in particular, enjoy therapy with this colorful, interactive, video game because they receive immediate feedback on their performance. Clinicians will enjoy the versatility and unique features of this technique. For example, while a child is playing a game, you can quickly review the graphical display or statistical data of the child's performance. This technique is divided into two groups: 1) *Awareness* teaches children about the attributes of their voice, and (2) ***Skill Builder*** gives the user goals to achieve for a given range and time. The examples of comprehensive user logs and tracking client's progress are provided. Best of all, real-time recording and playback gives you the tools you need to maximum your client's therapy.

Innovative computer technologies are not only helping the needs of persons with speech disorders, but also serving the laryngologists and speech pathologists to perform a more accurate and professional service.. With *a PC desktop or laptop computer, a 16-bit sound card, a microphone and speakers,* the clinician has met the simple requirements for starting and operating a speech laboratory in the clinical practice.

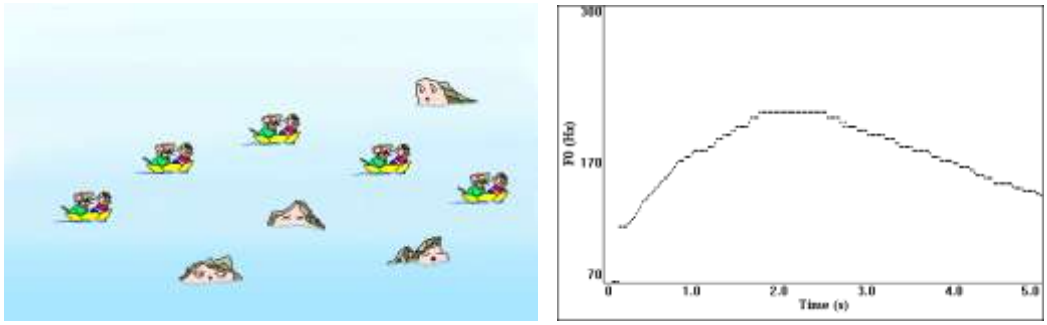
Speech is a product of the interaction of respiratory, laryngeal and vocal tract structures. The larynx functions as a valve that connects the respiratory system to the airway passages of the throat, mouth and nose. The vocal tract system consists of the various passages from the glottis to the lips. It involves the pharynx, oral and nasal cavities, including the tongue, teeth, velum, and lips. The production of speech sounds through these organs is known as articulation.

For speech skill builder, it is necessary for us to focus on the acoustical and physiological phenomena in both laryngeal and vocal tract systems. The parameters, such as, pitch, loudness, voicing, voicing onset, phonation time and formants, are closely related to these two systems. This paper employs *Speech Therapy* program, a clinical software from Tiger DRS. This software provides real-time cartoon displays of continuously varying pitch, loudness, voicing, voicing onset and phonation time displays so the children can receive immediate feedback on his/her performance with fun. In other words, the acoustical and physiological phenomena from the

children can be evaluated from this technique. Clinical application of this technique will be described in the following experiments for details.

Experiment 1: Pitch Skill Builder

Using pitch module, clinicians could help the children refine pitch control and develop smooth modulation of pitch contour. Certain patients are unconsciously or consciously making an effort to higher or lower their pitch. The clinician should teach patient to target optimum pitch by the control of vocal fold vibration. For example, one of the best way to refine pitch control is to use rise-fall pitch technique. In the Figure 1 (a), by extending /a/ in front of microphone, the boat moves around the rocks based on a rise-fall pitch pattern. With this game, the children receive immediate feedback on their pitch performance. After the game, the clinicians can look at objective information of the pitch control, as shown in the Figure 1 (b). In clinical practice, the clinician may select different pitch patterns for different needs of the patients.



(a) Real-time cartoon display (b) Objective information of pitch curve

Fig. 1. Pitch controls how the boat moves around the rocks (target: rise-fall pitch pattern)

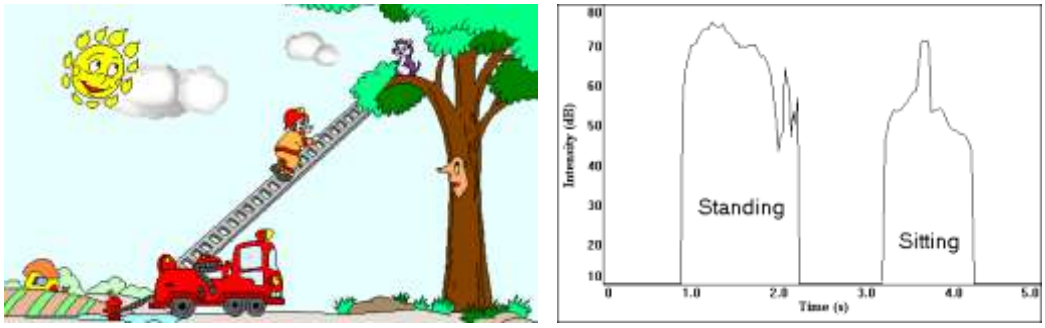
Pitch measure provides information about intonation. The pitch is mainly decided by the rate of vocal fold vibration. In the Pitch Skill Builder, the clinicians should help the patients to find the optimum pitch and pitch range and how to maintain this optimum situation. In clinical practice, a complete statistical report before or after therapy is important. The Table 1 lists the pitch changes during three-week therapy by pitch skill builder technique for the male patients with female voices. The result of speech therapy is obviously.

Table 1: Pitch changes during three-week therapy

	Patient 1 (male, 12 y)	Patient 2 (male 15 y)	Patient 3 (male, 17 y)	Therapy Technique
Ave. Pitch (week 1)	282 Hz	325 Hz	208 Hz	
Ave. Pitch (week 2)	253 Hz	287 Hz	181 Hz	Warm-up "rise-fall pitch" skill builder
Ave. Pitch (week 4)	232 Hz	262 Hz	157 Hz	Warm-up "flat-pitch" skill builder

Experiment 2: Loudness Skill Builder

Using loudness module, clinicians could help the children lower the loudness level of speech when the usual level is higher, and higher the loudness level when the usual level is lower. The clinician should teach the patient to control his/her loudness change by the correct control of breathing. For example, one way to control loudness is to use correct control of breathing and body position. In the Figure 2 (a), by increasing the loudness through a good body position, the fireman climbs higher toward the top target. With this game, the children receive immediate feedback of loudness changes with their different body position (standing vs. sitting). After that game, the clinician can look at the different loudness data (standing vs. sitting), as shown in the Figure 2 (b). The top target corresponds to a certain loudness level that can be modified by the clinicians.



(a) Real-time cartoon display (b) Objective information of loudness curve

Fig. 2. Loudness controls how higher the fireman climbs (target: top).

Loudness measure provides information about syllable stress. The intensity of vocal fold vibration is decided mainly by the loudness. In the Loudness Skill Builder, the clinicians should find the best way for the patients to make a target. The Table 2 lists the loudness changes during seven-week therapy by loudness skill builder technique for the patients with right RLN paralysis. The result of speech therapy is obviously.

Table 2: Loudness changes during seven-week therapy

	Patient 1 (male, 11 y)	Patient 2 (male 13 y)	Patient 3 (male, 14 y)	Therapy Technique
Ave. Loudness (week 1)	61.1 dB	66.5 dB	68.2 dB	
Ave. Loudness (week 3)	63.4 dB	67.1 dB	69.1 dB	Warm-up. Standing phonation by turn-head left. Loudness skill builder with correct control breathing.
Ave. Loudness	66.2 dB	67.8 dB	71.3 dB	Warm-up. Sitting phonation by turn-

(week 8)				head left. Loudness skill builder with correct control breathing.

Experiment 3: Voicing Skill Building

Using voicing module could help the children assess their voiced and unvoiced phonation from the computer screen. Voicing refers to the vocal behavior by which the conversion of continuous airflow into a series of glottal pulses is regulated. Voiced phonation, such as /z/, is regulated by the vocal fold vibration, while voiceless phonation such as /s/, is not regulated by the vocal fold vibration. For example, one way to feel voicing is to produce a pair of phoneme /s, z/, /f, v/ etc. In the Figure 3, when you phonate a voiced sound, a mouse (red) will come from left side; when you have a voiceless sound, a mouse (green) will appear from right side.

Fig. 3. Voicing mode determines which of the mice will run.

Voicing measure provides information about phonatory pattern. Using voicing onset module, clinicians could assist the children with modification of glottal attacks before the appearance of supraglottal articulatory event.

Experiment 4: Voicing Onset Skill Building

Using voicing onset module, the clinician can help the children to control the vocal fold attacks correctly. In the Figure 4, when you initiate a voiced phonation, a flower will open. If you saw /ba/, /po/, the first flower will open at the beginning of /b/, and the second flower will open at the beginning of /o/ because /p/ is a voiceless phoneme.

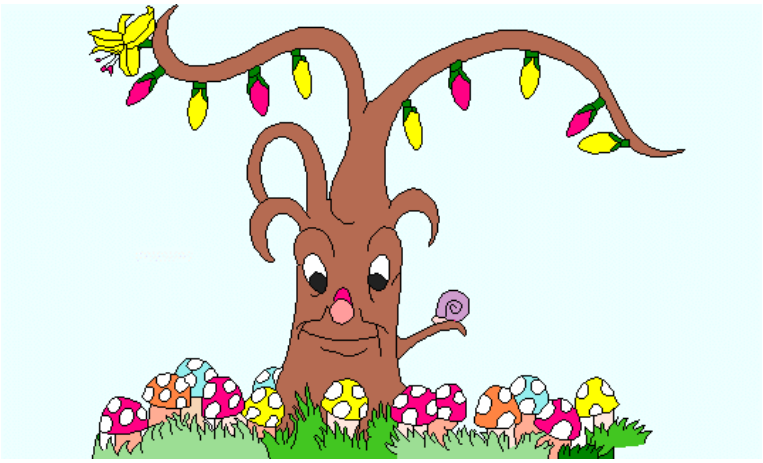


Fig. 4. Voicing onset mode controls how the flower opens around the tree.

Voicing onset provides information about glottal attacks. How fast can you make the ten flower open ? What happens if you extend a vowel, but have voice breaks ? All these cases depend on the voicing onset.

Experiment 5: Phonation Time Skill Building

The term, Maximum Phonation Time (MPT), implies such abilities in voice production as how long one can sustain phonation. The patients are instructed to sustain vowel /a/ or other vowel as long as possible following deep inspiration. MPT is decreased in many pathological states of the larynx, especially in cases with incompetent glottal closure. MPT values smaller than 10 seconds should be considered to be abnormal. For example, the clinicians should provide the patients the best way to make the respiration and phonation correctly. In the Figure 5, the strawberry moves from left to right when you keep phonation after deep inspiration. The target for you to reach is at right side. The target setting can be changed for the needs of patients.

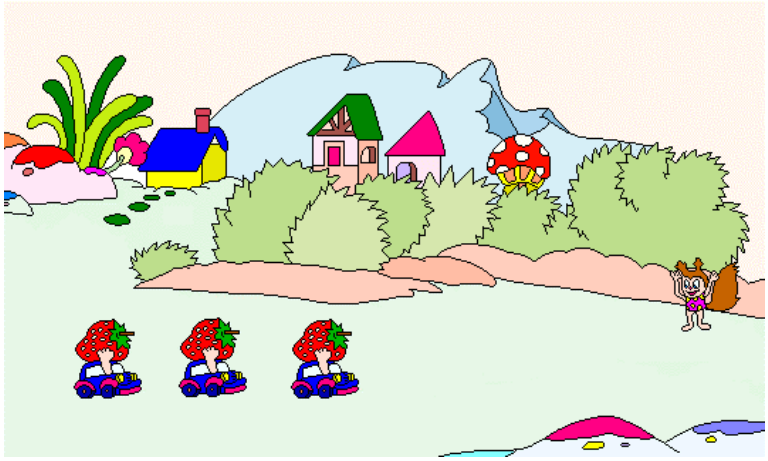


Fig. 5. Keeping phonation moves the strawberry from left to right.

Experiment 6: Speech Articulation

Speech articulation within vocal tract is determined by three major factors: the place of major constriction, the degree of constriction at that point and the lip constriction, as in Figure 6 and Figure 7. The vocal tract shape and lip movement will be provided for each vowel and consonant. In clinical practice, a brief education about speech articulation (tongue and lip movement) should be provided before therapy.

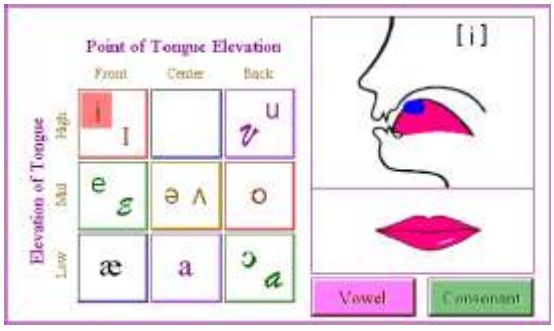


Fig. 6 Vowel production (vowel /i/)

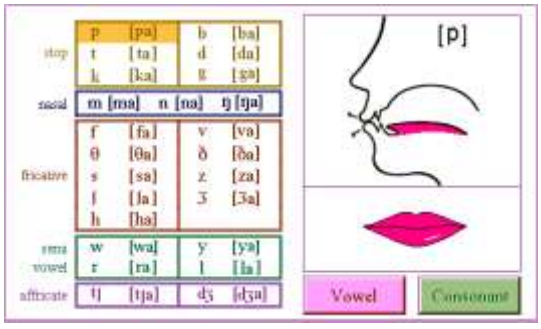


Fig. 7 Consonant production (vowel /p/)

Real-time vowel space training reveals first and second formants for speech inputs. With this tool, clinician can show patient about the effect of major constriction place in vocal tract from computer screen. The tongue tip movement mainly determines the second formant changes. For example, when the children produce a series of vowel /I-e-æ-a -u/, the vowel tracking will appear as in the Figure 8. By the graphic display, the clinician can judge the tongue tip position and phonetic accuracy quickly.

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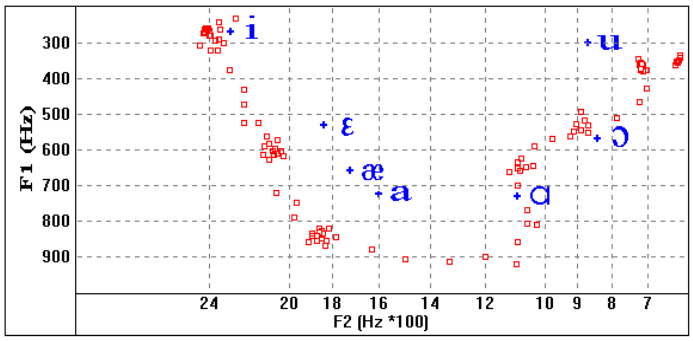

Fig. 8 Dynamic vowel tracking

Experiment 7: Sound Awareness

In Sound Awareness module, the children should understand normal speech level. Another important thing is to have children to understand difference among non-speech, speech, whistle and hiss. In the Figure 9, the clinicians can help patients to understand how much loudness or effect is necessary to move the graphic. The sound can be set to indicate a normal. conversational speech level. If you set it too high, you might not get the object to move at all.

Fig. 9. A seesaw moves when there is a sound over silence setting.

Vagmi :

Therapy modules are easy to use software tools that effortlessly convert P.C. into therapy equipment. No programming skills are required to use these modules and even your child can be his or her own therapist. These modules are visually appealing with exciting graphics and re enforcement messages. Using Vagmi therapy modules, clinical reports to great scientific accuracy can also be generated. The following are the therapy modules:

1. Vagmi Picture-Word-Articulation (PWA) Module can be used

(a) As a Phonic drill to (test) evaluate the pronunciation of speech sounds for the hard of hearing as well as children with normal hearing and identify the sounds whose pronunciation have to be corrected

(b) For stroke patients in helping memory recall

(c) To learn a secondary language at word level

This module is currently available in **English, Kannada, Telugu, Hindi, Oriya, Arabic, and is easily programmable by an experienced user to any desired language.** Also, the existing test can be modified by adding various different pictures and sound clues. A **parent supervisor** or a **therapist** or a special teacher accompanying the client grades the pronunciation as 'poor', 'just ok', 'fair'; 'average', 'good', etc. A corresponding **reinforcement** is given. The score achieved is saved. Pictures and words for **all the speech sounds of a language** may be tested in the picture-word-articulation test. Based on the overall performance, the next step to be followed can be decided. For example, after the test, if it is observed that the client is unable to pronounce the 's' sound properly, then the test can focus only on the 's' sounds.

2. Vagmi Therapy Pronunciation Module

There are two broad categories in this module:

- **Discrimination tests** for fricatives (s, sh, z), stops (p-b, t-d, k-g), laterals (l, r) and nasals (m, n)

'If one cannot discriminate the sounds, one cannot produce the sounds'**.** Here, the client should be able to distinguish if the consonant in a pair of words is the same or different. After testing his/her ability to discriminate, the pronunciation may be corrected.

- **Production therapy**

  When a client is identified with an inability to produce a particular speech sound correctly, such incorrect pronunciation of vowels or consonants can be corrected with the help of appropriate graphs, games, challenges and tasks incorporated in this therapy module.

  A **unique feature** developed out of scientific research and effort by Dr. TVA is the **display of tongue and lip shapes** for **vowel pronunciation** and the **subtle distinction between s and sh**. These are in a very effective way incorporated and displayed in our pronunciation therapy module aiding the child or the client in getting the pronunciation right within very few attempts.

  SpeechViewer III is a sophisticated clinical tool that takes advantage of the computer's multimedia capabilities. It has a menu bar for quick and elegant access to speech exercises, point and click capability and enhanced phoneme model creation. There is a full range of speech exercises, from creating awareness of speech elements to building skill in those elements. Vibrant color animations and visual feedback of speech attributes includes pitch, loudness, voicing, timing, spectra, phoneme pronunciation and co-articulation. The auditory feedback synchronizes with the color graphic display of speech patterns (e.g. a teddy bear moving, a balloon expanding, a bouncing ball etc.). Audio can be replayed at normal or slower speeds. The exercises have been designed as 'games' and this format will appeal to clients. The graphics are clearly drawn and are age appropriate with a choice of 4 exercises for most of the elements. Each exercise has a variety of graphic designs to keep therapy sessions interesting and therefore engage and involve the client in the activity.

  The Exercises Menu

  Each exercise is very clearly listed and described in the User Guide and in the Online Help system. The Purpose, Starting and use of the Settings sections are easy to understand and follow, even for a lay person! The 34-page tutorial is a comprehensive guide to using SPV3 more effectively and provides excellent background information as to its usefulness and application.

When you choose a client ID, or click on Start, you are presented with a menu with 13 items. These include:

Sound Presence	enhances awareness of sound (four delightful games)
Loudness Range	enhances awareness of the loudness of sound (e.g. a meter, a balloon expanding)
Voice Presence	develops an awareness of voicing (a clown changes colour, a man's lips move)
Voice Onset	increases the awareness of voicing onset and control over voicing
Voice Timing	improves coordination of respiration and voicing
Pitch Range	increases awareness of vocal pitch and quantifies pitch range
Pitch Control	builds skill in voluntary fine control of pitch
Phoneme Accuracy	improves the accuracy of phoneme production (using a fun game format)
Multi-phoneme Chains	develops skills in pronouncing a sequence of different phonemes
Two-Phoneme Contrast	improves accuracy in contrasting phonemes

Four-Phoneme Contrast	improves accuracy in contrasting phonemes
Pitch and Loudness Patterning	increases skill in producing acceptable speech patterns
Spectra Patterning	Uses spectral analysis to improve accuracy of phoneme production.

On the Menu Bar you see four groups. These each suggest exercises that you might consider for each speech parameter. The groups are Pitch, Prosody, Voicing and Phonology. Each of the exercises has a sub menu (e.g. Sound Presence has Alien, Dog, Flamingo and Kaleidoscope). Some will suit younger clients, whilst others will appeal to older users. At the base of the screen appears a Status Bar. It indicates such things as the conditions that have been set, who is speaking (the clinician or the client), the integrity and status of the statistics, whether the threshold is too loud and shows the microphone status (on or off).

2.2 Use of Computer Based Speech Equipment for Management of Voice in Children with Hearing Impairment

Profoundly hearing-impaired children often suffer from disorders of physiological control like deviant respiratory patterns as well as breathiness, voice breaks, unstable pitch, nasality and vocal fry. This is due to a restricted use of the vocal apparatus and the fact that they have to learn oral language by a laborious visual imitation of speaking (Grewel, 1963). Non-visible speech elements like for instance, nasality, voicing, and fundamental frequency can be related to typical deviations in the speech of profoundly hearing-impaired children (Martony, 1971; Monsen, 1976; Öster 1992b).

2.2.1 Nasalance Module

In this module, the speech output from the lips (oral level) as well as the nostrils (nasal level) is broadly separated and their respective levels are measured. **Thus one can become aware of the level of the speech output coming from the nostrils and lips separately. For example, when a word like 'appa' if said properly, has no nasalance. On the other hand, when a word like 'amma' is said properly, there will be a presence of a nasal sound in the word. The colourful display of the levels in this module helps even a hard of hearing client to become aware of the production of nasal sounds.**

Nasalence Measurement

When Nasalence is measured quantitatively, for an ideal voice, for steady vowels, the nasalence must be 0%; In case of **'hyper-nasality',** if the problem is due to lack of awareness, rather than an organic disorder, therapy is your solution.

Ideally, when pronouncing 'm' or 'n', nasalence must be as high as possible (>80%). If not, the case is called **'hypo-nasality'** and can be corrected using therapy if the problem is due to lack of awareness, rather than any organic disorder.

The unique feature of the various modules developed by Voice and Speech Systems is that it not only provides therapy for various and numerous dimensions of voice and speech problems but it also gives you an option to measure your deviation from the normal. Using Vagmi Therapy Nasalence Module one can not only **correct hyper or hypo nasality** by means of **interesting games** but also first **measure** the degree of deviation from the normal voice quality and the **severity of nasalence** in one's voice.

There is an organ called '**velum**' near the root of the tongue. Sometimes this is referred to as 'little tongue'. This acts as a valve. Lifting this valve leads to the blockage of sounds via the nostrils producing a nasal voice. On the other hand, this valve or the velum has to be lowered to produce sounds such as 'm', 'n'. When a person is unable to control the movement of velum and if it is always in a lowered position then his/her speech sounds highly nasal. This is called 'nasal voice'.

The inability to move the velum may be because of **lack of awareness or bad practice**. In such a case therapy programs help one become aware of the action of velum and there by learn to regulate it. On the other hand, if the nerve connecting to the muscles of the velum is unable to activate it, it is a permanent damage, may be since birth – a **congenital defect**. In such a case therapy will not help.

2.2.2 Therapy for Breath Support Module

The duration for which a client is able to say a **steady vowel with a single breath** is referred to as the maximum phonation duration (MPD) or maximum phonation time (MPT). Poor MPD may arise either because of **poor respiratory support** or **inefficient use of the available air in the lungs**.

Vagmi Therapy Breath Support Module gives you Measurement or Assessment as well as Therapy menu options to help increase breath support such that the client is able to talk with strength in their voice and for longer duration without getting tired.

- **Voice Initiation and Sustenance**– This is a measurement program to verify if the client's voice has sufficient respiratory support.
- **MPD Measurement** – This is to measure the MPD as well as to check the steadiness in the client's voice.
- **MPD Therapy** – This has a number of games like Pacman, puzzles and many challenges to help the client increase their breath support to be able to talk for a long duration comfortably.

2.2.3 Therapy for Voice Control Module

If voice is of breathy quality, a qualified speech language pathologist or ENT specialist can ascertain this using the menu options **'Acoustic Glottogram'** for measurement and **'Glottal Leakage for therapy**.

Acoustic Glottogram

The phonation signal of a steady 'aa' or 'A' is recorded and the air flow through the glottis is deduced. The 'pattern' or the 'shape' of the **air flow** through the glottis depends on the manner of **vibration of the vocal folds.** Thus an experienced professional can interpret the voice quality as breathy or modal or pressed or falsetto by looking at this pattern. Also, the opening, closing and closed durations relative to pitch period can be deduced. Using the pattern displayed as a feedback, the client may try to improve the voice quality.

Glottal Leakage

The duration for which a client can say a steady vowel with a single breath is referred to as the maximum phonation duration (MPD). Although the respiratory support of the client is good, the **air stored in the lungs may be depleted very fast** due to the client's **breathy voice**.
This module provides a graphic display corresponding to the voice quality of the client. One has to achieve as large a phonation duration as possible while maintaining a good voice quality.

Voice Focus

The pronunciation of sounds must be clearly enunciated. If the movement of the **articulators-** tongue, jaw and lips is highly **restricted** then the voice quality is poor. Examples of poor voice quality are 'clenched teeth', 'palatalized' etc.
The client is asked to say steady vowels or vowels in a context. Then, the module measures and gives a graphic display of the spread in **'vowel space'.** When the vowel space of the client is compared with the vowel space of a normal reference, it gives an idea about how clustered or blurred one's voice is for correction.

2.3 Use of Computer Based Speech Equipment for Management of Suprasegmentals in Children with Hearing Impairment

Children with hearing impairment have been found to have a monotonous rhythm due to incorrect pausing between syllables. Sometimes their fundamental frequency is extremely high with a lowering at the end of every vowel. The children also had extended segment duration.

Children with a normal speaking rate however may not have fluent speech fluent, due to the fact that they breathe after every second word. They may emphasize the beginning and the end of every sentence. The most interesting deviation is vowel-dependent fundamental frequency variation because of an excessive articulatory tension. Some children might have a normal fundamental frequency but a remarkably slow tempo. Furthermore, they might as well extend the occlusion phase in the production of the plosives /p, t, k/. The prosodic deviations of each child forms the basis for the rules used to generate the prosody of the simulated speech. The following module is usually incorporated for management of suprasegmentals:

2.3.1 Intonation and Accent Module

Intonation

The **variation in pitch over the length of an utterance** is measured while a client speaks and it is determined if the client's voice has some intonation or is dull, flat or monotone.

By testing the steadiness in voice, this module also helps as a **preliminary screening tool of a voice disorder.** This feature can also be used for **practicing to sing a musical note** at a particular appropriate pitch. Also, the same program may be used to measure the **range of pitch**– lowest to highest. By displaying the volume instead of the pitch, **rhythmic patterns of short and long vowels in syllables** also may be displayed.

Accent

This feature is **language independent.** A model utterance of **any language** can be recorded and saved. This model intonation pattern to be achieved can be displayed in the upper window. The intonation of the client's production is shown in the lower window for comparison to achieve the desired intonation of the chosen language. The client can also listen to the model utterance and compare it with his/her own production thus getting close and achieving the desired intonation pattern.

2.4 Basic infrastructure required for using computer based speech training aids/equipment

2.4.1 Room and equipment:

For an effective computer based speech training it is pertinent to have a few stringent criterions. According to Rehabilitation council of India guidelines an institute with speech science lab should ideally be a quiet room. The average size of the room should be (6*6) sq. ft.. With computer PC- AT with VGA color monitor. Hi- fi ampli deck with speakers and good microphone, software for diagnostic/therapeutic use, audio cassettes for training. Other important factors to be considered are a well lit room with good aeration. Comfortable seating arrangement and a less reverberant room is desirable. The cleanliness of the room and equipment is essential. Power cables should be nicely secured. A power back up with voltage stabilizer is also required for unobstructed training program.

2.4.2 Speech training system: What distinguishes a good computer-based speech training system? Throughout the literature many design considerations are mentioned, but few are collected into a theoretical framework against which different systems can be compared or analyzed.

Watson and Kewley-Port (1989) argues that a good system should possess the same properties as a speech therapist and defines this with the following characteristics;

- being able to assess the speech of a child and distinguish problem areas, being able to make a treatment plan
- Give cues in form of produced speech; give feedback based on the child's production and keep records of how the child performs.
- physical source of feedback, from which modality is the information of the speech production obtained, standards of evaluation, what kind of model should be used to compare the speech production with and level and type of detail on which feedback is based, that is how much processing should be done before the result is displayed and in which form it should be displayed.

Mahshie (1995) also carries out a discussion on good computer-based aids and does this from three main pedagogical factors. The *task and target skills the child needs to learn, the cues given to the child and the feedback* on how good the production was. Interesting here is perhaps the task and target skill that is not mentioned by Watson and Kewley-Port. Other important considerations mentioned in the literature are those concerned with most computer-based

systems. The system must be easy to use, clear instructions are needed and, the system must be acceptable for both therapists and children (Oster 1996).

• Clear instructions and pedagogical manuals must be created and made available for use with different groups of children.

• The visual feedback of the child's voice and articulation should be shown immediately and without delay.

• The aid must be acceptable to the therapist as well as to the child, which means that the aid must be attractive, interesting, easily comprehensible, easy to handle, and motivating.

• The visual pattern must be natural, logical and easily understandable. This means that training parameters as, e.g., pitch could be shown vertically as pitch variations occur; intensity through the size of an object that becomes larger as a sound becomes louder and smaller as a sound becomes softer; intonation and stress through a continuous red curve; duration could be shown horizontally and voicing through a relationship between voicing and the change of a color.

• The aid should provide a contrastive training, that is, the correct model of the therapist and the deviant production of the child are shown simultaneously and compared with each other. • The aid should provide a flexible, individual, and structural speech and voice training and give an objective evaluation of the child's training results.

2.5 TELE SPEECH THERAPY/TELEPRACTICE

2.5.1 Tele Speech Therapy /Telepractice is the application of telecommunications technology to the delivery of speech language pathology and audiology professional services at a distance by linking clinician to client/patient or clinician to clinician for assessment, intervention, and/or consultation. Supervision, mentoring, and pre-service and continuing education are other activities that may be conducted through the use of technology.

The term **telepractice** is rather frequently used terms **telemedicine** or **telehealth** to avoid the misperception that these services are used only in health care settings. Other terms such

as **teleaudiology telespeech**, and **speech teletherapy** may be used in addition to **telepractice**. Services delivered by audiologists and speech-language pathologists are also included in the broader generic term **telerehabilitation** (American Telemedicine Association, 2010). **Telepractice is an appropriate model of service delivery for audiologists and speech-language pathologists.**

Telepractice venues include schools, medical centers, rehabilitation hospitals, community health centers, outpatient clinics, universities, clients'/patients' homes, residential health care facilities, childcare centers, and corporate settings. There are no inherent limits to where telepractice can be implemented, as long as the services comply with national, state, institutional, and professional regulations and policies.

2.5.2- Types of Tele speech therapy-

The two most common terms describing types of telepractice are **synchronous** (client/patient interactive) and **asynchronous** (store and forward).

a) Synchronous services are conducted with interactive audio and video connection in real time to create an in-person experience similar to that achieved in a traditional encounter. Synchronous services may connect a client/patient or group of clients/patients with a clinician, or they may include consultation between a clinician and a specialist (Department of Health and Human Services, 2012).

b) In asynchronous services, images or data are captured and transmitted (i.e., stored and forwarded) for viewing or interpretation by a professional. Examples include transmission of voice clips, audiologic testing results, or outcomes of independent client/patient practice.

c) Hybrid applications of telepractice include combinations of synchronous, asynchronous, and/or inperson services.

2.5.3- Rules and Regulations of Telepractice:

- Individuals who hold the degree in Speech language Pathology and audiology should be trained in telepractising can only perform this service.
- Professionals shall evaluate the effectiveness of services provided, technology employed, and products dispensed, and they shall provide services or dispense products only when benefit can reasonably be expected.
- Individuals shall make use of technology and instrumentation consistent with accepted professional guidelines in their areas of practice. When such technology is not available, an appropriate referral may be made.
- Individuals shall ensure that all technology and instrumentation used to provide services or to conduct research and scholarly activities are in proper working order and are properly calibrated.

2.5.4-Roles and responsibilities for audiologists and SLPs in the provision of services via telepractice include

- understanding and applying appropriate models of technology used to deliver services;
- understanding the appropriate specifications and operations of technology used in delivery of services;
- calibrating and maintaining clinical instruments and telehealth equipment;
- selecting clients who are appropriate for assessment and intervention services via telepractice;
- selecting and using assessments and interventions that are appropriate to the technology being used and that take into consideration client/patient and disorder variables;
- being sensitive to cultural and linguistic variables that affect the identification, assessment, treatment and management of communication disorders/differences in individuals receiving services via telepractice;
- training and using support personnel appropriately when delivering services;
- being familiar with the available tools and methods and applying them to evaluate the effectiveness of services provided and to measure outcomes;

- maintaining appropriate documentation, including informed consent for use of telepractice and documentation of the telepractice encounter;
- being knowledgeable and compliant with existing rules and regulations regarding telepractice including security and privacy protections, reimbursement for services, and licensure, liability and malpractice concerns;
- collaborating with physicians for timely referral and follow-up services (Hofstetter, Kokesh, Ferguson, & Hood, 2010);
- using web-based technology to engage clients through virtual environments and other personally salient activities (Towey, 2012).

Telepractice is constantly evolving. Ongoing education and training is required to maintain expertise and familiarity with changes in technology and potential clinical applications.

Let us sum up

The speech therapist along with educator is irreplaceable and must be present in all stages of speech teaching. The speech therapist is necessary not only to evaluate the deviations of the child's speech and to make a plan of suitable exercises, but also to judge the mood of the child and depending on it make the speech training session as motivating as possible.

An efficient CBST system must allow the speech therapists to easily adapt and refine the exercises depending on the development and motivation of the child during the supervised sessions. In a human-led session, the therapist makes quick changes between exercises and aids in order to make the session as fulfilling and stimulating as possible. This variation and knowledge are extremely difficult to mimic automatically with a computer-based system, but given the functionality a therapist would make the right choices.

A computer-based speech training aid would be of most help if it supports repeated practice without the help of a speech therapist. Automation of the speech, that is to practice a speech sound until it can be produced automatically without being aware of how it is done exactly, requires much practice. Usually there is not enough time to accomplish this during speech sessions. If there were systems available that could give corrections without assistance from a therapist, the repeated practice to automate the speech sounds could be done by the child on her/his own.

A speech training aid should be easy to adapt to the child and his/her problems. Every child with a speech deficit is unique and has unique difficulties. Another reason for adaptability is the motivational factor. Depending of the mood of the child, the system must be adaptable in order for the therapist to find an exercise that motivates the child enough to practice more. A CBST system should support language learning. Speech training is much more than just practicing on producing speech sounds. Children with speech deficits often have a second impairment in the form of a language deficit, and the therapist helps the child to further develop the language that the child already has conquered. The material used in a computer-based system should relate to the daily life of the children using the system. The therapist tries to connect the exercises with the daily life of the child in order to support and develop the child's own language. It is natural that a CBST ideally should do the same. User Profiles There should be a possibility to store the sounds being trained. This feature is important as a way to record the development of the child, but also to strengthen the connection between training and the child's own life. A CBST should provide the possibility to store pictures and text together with the speech sounds. A reoccurring tool in speech training is a physical notebook, in which pictures and text used in the training are collected. This tool should be adapted to the CBST situation. Using an electronic note-book such as Digital Portfolio [13] the therapist can enhance the connection between the training and the child's experience by adding items that are relevant to the child. As an example, the exercises could be illustrated with digital images of the child's own life. The interactive electronic note-book would hence make the system more adaptable and make it easier to vary the exercises in order to avoid that the training becomes boring. Due to the variability of the deviations that the children have, the system should ideally have the same variability.

Rewards: Rewards should be distributed according to the effort made by the child, and not only the result of the child's attempts. When talking about rewards during one of the interviews, the problem of how to distribute the reward came up. The therapists agreed that the notion of rewards is good, but that current CBST systems often distribute the rewards based only on the result. An example of this is a game where the child steers a car with its voice and is supposed to avoid colliding with obstacles. The reward, a cheering sound, is only given if no collisions occurred, which seems hard on a child who has been trying hard and collided only once during the game. Another example is implementations where the child gets to play a game as a reward after producing a specified amount of good pronunciations. Since the children are at different

levels and some children have enormous difficulties that might not ever be overcome, some children may never get to play a rewarding game or only play for a short time, if rewards are distributed according to results. The teacher should be able to vary the amount of reward in a computer-based aid. This feature is needed not only because the children are different from each other, but also due to the fact that the child develops and acquires new skills.

Parental Involvement If the system or parts of the system should be used outside the school, or without the presence of a therapist, the exercises must be different than those used by the therapist. Many parents would like to be more involved in the speech training.

Check your progress

- Discuss some of the computer based speech training programmes
- Discuss the management of voice of children with hearing impairment
- Discuss the management of suprasegmentals in children with hearing impairment
- What are the basic infrastructure requirement for using computer based speech training aids/equipment
- Discuss about tele speech therapy

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