1. Introduction

When someone in the family has a hearing loss, the entire family has a hearing problem.

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The process of communication is known to involve mutual interactions where people serving as talkers and listeners, share ideas, thoughts, experiences, and feelings. The efficiency of this process is acknowledged to be dependent on each of the participants. In order to enable fluent conversation, it is established that each person should be sensitive to the needs of others (Wiseman & Barker, 1976; Palmer, 1988). One of the reasons known to result in a breakdown in communication is the presence of a hearing impairment. Irrespective of the age of the individual, hearing impairment is known to result in a communication breakdown. However, it is well-known that children with hearing impairment are at a greater risk for communication breakdown than adults (Davis & Silverman, 1978; Elfenbein, 1992; Tye-Murray, 2009).

Rehabilitation of individuals with hearing impairment is considered essential to alleviate their communication problems. Erber (1982, 1988) reported that, while planning aural rehabilitation for individuals with hearing impairment, a clinician must establish whether the person perceives the spectral qualities of sounds or seems to perceive only the intensity patterns. The audiogram may provide only limited information to make such a decision. Hence, it was suggested that the individual should be evaluated using speech materials. These tests would help in determining the speech perception abilities of those individuals have hearing impairment but with some amount of residual hearing.
Auditory training, which is considered an important facet of aural rehabilitation, has been shown to be effective in the rehabilitation of hearing aid users (Sweetow & Palmer, 2005; Sabes & Sweetow, 2007; Wu, Yang, Lin & Fu, 2007). Several other studies have also confirmed this (Busby, Roberts, Tong, & Clark, 1991; Blamey & Alcantara, 1994; Stout & Windle, 1994; Moog, Biedenstein, & Davidson, 1995; Dawson & Clark, 1997). Similarly, studies done in India also corroborate this fact (Rao, 1998; Anitha, 2002; Vijayalakshmi & Yathiraj, 2003-2004; Manoharan & Yathiraj, 2007-2008). However, the vast majority of these programs require the assistance of a clinician to carry out the activities and cannot be done independently by the client.

The use of computer based auditory training programmes have been recommended to be used as home based activities (Wu et al., 2007; Miller et al., 2007; Sabes & Sweetow, 2007). Despite computer based auditory training programmes having been in vogue for several years (Fletcher & Stauffer, 1973; Boothroyd, Archambault, Adams, & Storm, 1975; Bernstein, 1989; Watson & Kewley-Port, 1989; Tye-Murray, Tyler, Lansing & Bertschy, 1990; Fu, Galvin, Wang, & Nogaki, 2005; Miller et al., 2007; Sweetow & Sabes, 2006), the utility of only a few as home-based training programmes have been reported (Fu et al., 2005; Miller et al., 2007; Sweetow & Sabes, 2006). Of the commercially available programmes, those whose utility has been verified include Computer-Assisted Speech Training [(CAST), Fu et al., 2005], Listening and Auditory Communication Enhancement [(LACE), Sweetow & Sabes, 2004; 2006], and Speech Perception Assessments and Training System [(SPATS), Miller et al., 2007]. These home-based software programmes are reported to be innovative, cost effective and interactive.

Kant and Adhyaru (2009) published regarding a computer-based auditory training programme developed by them in India. However, they reported that the stimuli were presented
either through audio cassettes or using live voice to check the utility of the programme on children. The actual utility of the stimuli presented via CD-ROM was not evaluated.

It has been ascertained that computer based listening training brings about enhanced speech perception in individuals with hearing impairment (Fu et al., 2005; Sweetow & Sabes, 2006; Burk & Humes, 2007, 2008; Miller et al., 2007; Stacey & Summerfield, 2008). Both home and laboratory based computer programmes have been shown to improve speech perception. The improvement has been observed for speech perception in the presence and absence of noise as well as on hearing handicap inventories. Thus, it has been established that intensive listening training using computer software does help in improving auditory perceptual skills.

Need for the study

Need for auditory training programmes.

It has been well authenticated that auditory training is highly useful in enabling those with hearing impairment improve their speech perception (Carhart, 1947; Erber, 1982; Clark & Watkins, 1985; Busby et al., 1991; Blamey & Alcantara, 1994; Stout & Windle, 1994; Moog, Biedenstein, & Davidson, 1995; Dawson & Clark, 1997). Auditory training has been found to be useful not only in children (Davis & Silverman, 1978; Erber, 1982; Van Tasell, 1981; Tye-Murray, 2009) but also in older individuals (Owens, Talbott & Schubert, 1968; Bode & Oyer, 1970; Walden, Erdman, Montgomery, Schwartz, & Prosek, 1981; Montgomery, Walden, Schwartz, & Prosek, 1984; Kricos, Holmes, & Doyle, 1992; Kricos & Holmes, 1996; Tye-Murray, 2002). Hence, age has not been found to be a detrimental factor in providing auditory training, as long as the individual has adequate language skills.
Neural plasticity has been noted to take place when multiple auditory experiences occur over time. This has been found to happen during auditory training, wherein new neural groups can form, grow and strengthen (Merzenich et al., 1999). According to Chermak and Musiek (1997) and Tallal et al. (1996), the auditory system needs to be challenged in an appropriate manner to trigger such changes in structure and function.

Since it is established that speech perception can improve with auditory training, there is a need to continue utilizing such programmes. Such auditory training programmes should be continued to be used not only in younger age group but also in older children and adults with hearing impairment.

\textbf{Need to develop an auditory training programme in India.}

In literature, the availability of numerous auditory training programmes in English has been reported. The utility of several of these programmes has also been established. Despite this, there is a need to develop auditory training material in India. This is necessary since Indian English differs from English spoken in other parts of the world. The difference is primarily in the accent, phonemes and vocabulary used. The accent of the existing recorded versions of auditory training programmes would not be readily followed by Indians, and would not be of utility in their day-to-day listening skills. Hence, merely rerecording existing western auditory training material would not be of considerable utility. Further, the auditory training programmes developed in other parts of the world do not give emphasis to the acoustic characteristics of speech sounds, which is an important component of auditory training.

The existing auditory training materials in Indian-English have limited activities and are not computerised. The auditory programme developed in India by Kant and Adhyaru (2009),
that is claimed to be computerised, has not actually confirmed its utility. Further, this programme has mainly used nonverbal material and the verbal content of the programme are not in English. Thus, it is necessary to develop auditory training material in India.

**Need to use speech stimuli for auditory training.**

The uses of speech stimuli for auditory stimulation have been preferred over non-speech stimuli. Ling (1976) opined that the use of non-speech stimuli does not help in the perception of speech stimuli. This was considered to happen because the acoustics of non-speech signals are different from that of speech; the two types of stimuli are processed in different hemispheres of the brain and the perceptual and memory strategies used for the two stimuli types are dissimilar. In addition to the view point of Ling, it is known that for day-to-day communication, speech stimuli have considerably more utility than nonverbal stimuli.

**Need for developing auditory training material incorporating acoustic characteristics.**

Studies have confirmed that individuals with hearing impairment have difficulty in hearing speech depending on the acoustic characteristics of the speech sounds. It has been noticed that even those with a moderate hearing loss show errors while perceiving specific consonants and vowels (Owens & Schubert, 1968; Pickett et al., 1972; Owens, 1978; Wang, Reed, & Bilger, 1978). Hence, the stimuli used to stimulate the auditory mechanism should have a variety of acoustical characteristics. It is essential that durational and frequency characteristics be considered while developing auditory training material. This would enable individuals with hearing impairment to perceive speech sounds with different acoustical characteristics.
Most of the available auditory training programmes, whose utility has been checked, do not contain stimuli that are categorised based on their frequency or temporal characteristics. The training materials generally contain groups of nonsense syllables / words / phrases / sentences, but have not been categorised based on their acoustic parameters. Thus, these programmes do not provide stimuli that would tap the specific perceptual difficulties that an individual with hearing impairment might have. The few programmes that have considered the acoustical characteristics of the stimuli have not confirmed their utility.

**Need for computer based auditory training programmes.**

In India, speech and hearing professionals as well as special educators are involved in providing auditory training. As on 2011, it is reported that there are 1873 speech and hearing professionals in the country (ISHA, 2011). Considering the number of individuals with hearing impairment in India, the available professionals in the country are highly inadequate. Hence, it would not be possible for a clinician to devote the required amount of time per client. Thus, to provide auditory training to such a large population with hearing impairment, computerized training modules are required. This would enable clients to work with minimal involvement of a clinician without compromising on the training being received to enhance auditory perception.

**Need to evaluate the utility of auditory training programmes.**

It is crucial that the utility of any auditory training programme be checked before it is recommended for use. An auditory training programme should bring about improvement in all major domains of auditory perception which includes awareness, discrimination, identification and comprehension. The programme should also bring about improvement in the perception of
different stimuli such as nonsense syllables, words, unrelated sentences and related sentences. Additionally, it should bring about improvement in perception in adverse listening conditions such as in the presence of noise. Evaluation of the utility of the programme would bring to light the potential of listening training in enhancing the perception of various listening skills. It would also help the clinician predict the performance of a client in the above mentioned auditory skills in everyday listening situations. Hence, it is necessary that an auditory training programme be evaluated with different types of stimuli and with different noise conditions to check its utility.
Objectives of the study

The main objective of the study was to determine the efficacy of a Computer-Assisted Listening Training (CALT) programme that was developed. The efficacy was evaluated at different intervals of time during the course of therapy (pre-therapy, mid-therapy, immediate post-therapy & follow-up). It was hypothesised that there would be no significant difference between the evaluations before and after training. To evaluate the hypotheses, the specific objectives of the study were to determine the following:

1. Awareness of speech sounds across three evaluations (pre, post & follow-up)
2. Speech discrimination ability of phonemes differing in terms of voicing, place of articulation and manner of articulation across three evaluations (pre, post & follow-up)
3. Identification of words varying in length across four evaluations (pre, mid, post & follow-up)
4. Monosyllabic word identification in different noise conditions (quiet, +20 dB SNR & +10 dB SNR) across four evaluations (pre, mid, post & follow-up)
5. Sentence identification in different noise conditions (quiet, & +20 dB SNR) across three evaluations (pre, post & follow-up)
6. Passage comprehension in different noise conditions (quiet, & +20 dB SNR) across three evaluations (pre, post & follow-up)