SPEECH IDENTIFICATION IN ADULTS: A COMPARISON BETWEEN COMPUTER AND CD PRESENTATION

(REGISTER NO. M 0103)

An Independent Project submitted in part fulfillment of the first year M.Sc (Speech and Hearing), University of Mysore, Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MANASAGANGOTHRI, MYSORE 570 006

MAY 2002

Certificate

This is to certify that the Independent Project entitled "SPEECH IDENTIFICATION IN ADULTS: A COMPARISON BETWEEN COMPUTER AND CD PRESENTATION" is a bonafide work done in part fulfillment for the degree of Master of Science (Speech and Hearing) of the student (Register No. M 0103).

Mysore

May, 2002

Director
All India Institute of
Speech & Hearing
Mysore-570 006

Certificate

This is to certify that the Independent Project entitled "SPEECH IDENTIFICATION IN ADULTS: A COMPARISON BETWEEN COMPUTER AND CD PRESENTATION" has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any Diploma or Degree.

Mysore

May, 2002

GUIDE

(Dr. Asha Yathiraj)
Reader & Head
Department of Audiology
All India Institute of
Speech & Hearing
Mysore-570 006

Declaration

This independent project entitled "SPEECH IDENTIFICATION IN ADULTS: A COMPARISON BETWEEN COMPUTER AND CD PRESENTATION" is the result of my own study under the guidance of Dr. Asha Yathiraj, Reader & Head, Department of Audiology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any other University for the award of any Diploma or Degree.

Mysore   Register No. M 0103

May, 2002

Dedicated to

MUMMY

&

PAPA

Who gave me the courage

to accept the things

which I can't change and

wisdom to know the difference

between right and wrong

ACKNOWLEDGEMENTS

*I thank and express my sincere gratitude to my guide **Dr. Asha Yathiraj,** Reader in Audiology, All India Institute of Speech and Hearing, Mysore for her patience, constant support and guidance throughout this project.*

*l am thankful to **Dr. MJayaram,** Director, All India Institute of Speech and Hearing for permitting me to carry out this study.*

*I thank Dr. **Venkatesanfor** helping me with my statistical analysis.*

*I would like to thank **Ajish Sir** and **Chudamani ma'm** for allowing me to take print out.*

*I thank **Sridevi ma**'m for helping me with the statistics.*

Special thanks to all my subjects for their cooperation.

***Mummy, Papa, Suraj Bhaiji, Akash Bhaiji, Bhabhi** and **Diksha** - Your love and affection has made me possible to finish this project. I love you all.*

"A friend is a gift which you give yourself."

***Ramya** - It would have been difficult to do this without you. Thanx for being there with me throughout.*

*Sandeep & **Gauri** - You will always be special friends to me.*

"Someone who will listen well and try to understand,

Someone whose friendship is rare and precious to me ".

***Ammu, Rakhi & Mammu** -I'm so glad v are friends. Thanks for spending time with me when I needed you and giving me moral support. I'll always remember the time spent with you guys.*

Savitha -*I'm glad you are always there near me when I need.*

Special thanx to ***Jayashree & Gupta*** *for helping out in recording the material.*

Sapna *- Thanx for giving me motherly love and support in the time when I needed.*
Richa, Tanuja, Amita, Punam, Shivani & Bindu - *had nice time with you all!! Remember U always!*

Kavita *&* ***Vina*** *- Thanx, for helping me out with my sentence formation.*

I thank all my ***classmates*** *(B.Sc & M.Sc) for moral support you have given me.*

I would like to thank ***Parimala mam*** *for giving a final shape to this project.*

LIST OF TABLES

TABLE OF CONTENTS

INTRODUCTION

"To hear is as natural and effortless an occurrence as it is invisible. Man would as soon ask himself how breathing keeps him physically alive as how hearing keeps him psychologically alive "

\- Levine(1960, pg 17)

If one had to select a single audiologic procedure to measure "hearing", it would have to be a speech based test. The ability to perceive and understand speech is, by far, the most important hearing function. Theoretically, speech audiometry is an attempt at "communicometry" i.e. a measurement of communication ability (Hall and Mueller, 1997). It can also add a great deal to the estimation of how much assistance one needs and can expect from various types of rehabilitation procedure (Berger, 1978).

Speech audiometry is concerned with answering at least three questions, (a) What is the lowest unit at which a listener can just barely identify simple speech materials? (b) How well does the listener understand everyday speech under everyday condition? (c) At what intensity does speech become uncomfortable to the listener? (Berger, 1978).

Speech tests have the following advantages: They could be used to confirm pure tone threshold; they are helpful in diagnosis of the type and degree of hearing impairment; can help locate the site of lesion; useful in selecting hearing aids and determining progress in therapy (Martin, 1994).

Speech audiometry is important in the measurement of communication ability and disorder. Hence, intensive investigation of speech audiometry materials and procedures has continued essentially unabated for over 50 years.

A wide variety of speech materials has been employed in the construction of speech recognition tests. They have included individual sounds, nonsense syllables, phonetic balance monosyllabic words, disyllabic words, sentences and continuous discourse (Stach, 1998). The use of monosyllabic word list has been widely accepted. This is mainly due to the fact that such tests must consist of relatively non-redundant items, otherwise the multiplicity of clues available to the listener can obscure some of the inabilities to differentiate speech sounds and their acoustical properties (Hirsh, 1964).

The mode of stimulus presentation also plays an important role in speech recognition test. It can be either live voice or recorded presentation (Olsen & Matkin, 1979). There are considerable advantages of using recorded speech when compared to live voice, for audiometric purposes. A few of them include: the intensity consistency within lists; uniformity of stimuli would be maintained; the tester is not a variable in the presentation (Rupp, 1980) and it offers test retest reliability (Fuller, 1987).

Live voice presentation also has several advantages such as it requires less time for the test to be carried out, greater flexibility in presentation of stimuli

(ASHA, 1988, cited in Silman & Silverman, 1991) and a certain amount of rapport is maintained through the verbal interplay between the patient and the audiologist (Martin, 1975).

On the other hand, Stach (1998) noted that monitored live voice has certain limitations like: word recognition scores obtained for different talkers are not equivalent the acoustic characteristics of the signal are highly variable. In addition, each speaker of word recognition materials constitutes a different test that may produce different psychometric articulation function (Hall and Mueller, 1997).

However, the American Speech Language and Hearing Association guidelines (1988, cited in Silman & Silverman, 1991) suggest that recorded presentation of test material is the preferred procedure. Recorded speech material can be presented through analog or digital tapes. Some of the disadvantages of analog tapes include lack of flexibility, deterioration of phonographic and tape recording resulting in signal distortion. In addition, it results in introduction of noise and is sensitive to ambient conditions (Stach, 1998).

The above can be overcome by digitized recording where one need not sacrifice quality, reliability and validity to obtain speed. Digitized recording can be through Compact Disc (CD) or computer. It is essential to know if the above two means of digitized recording can bring about a change in speech recognition scores.

The aim of the present study is to compare two different ways of presenting speech material to adults i.e., though a computer and through a CD. In addition, the following will also be studied:

- Effect of presentation levels on Speech Identification Scores (SIS).
- Sex difference in SIS.
- The effect of interstimulus interval on SIS.

Need for the study:

1. It is essential to know if there are any differences in test results while using computerized speech material when compared to CD stimuli.
2. In the literature, there is scarce information regarding the comparison between computerized speech material and CD material.
3. If there are no differences between CD material and computerized recorded material, then either of them can be utilized for clinical or research purposes. If there is a difference, depending on which material is better, it would be recommended that audiologist's utilize that particular method.
4. Currently, there are no computerized speech materials available for any Indian languages. Hence, it is essential to record a computerized test material in Indian languages.

REVIEW

Speech has evolved as a method of communication that not only provides a way of information transfer but also the means, in its written form, for information storage (Wright, 1987). Perception of speech is essential for production. It includes perception of the suprasegmental as well as segmental aspects of speech. In order to know that a person is perceiving speech effectively, it is essential to assess their perceptual abilities (Mendel & Danhauer, 1997).

Speech audiometry, therefore, is a key component of audiologic assessment. As it uses the kinds of auditory signal present in every day communication, speech audiometry can indicate, in a more realistic manner than pure tones, how an auditory disorder might effect communication. Speech measures can thus be used diagnostically to examine processing ability and the manner in which it is affected by disorders of the middle ear, cochlea, auditory nerve, brain stem pathways and auditory centers in the cortex. In addition, there is a predictable relation between a person's hearing for pure tones and hearing for speech. Thus, speech audiometric testing can serve as a crosscheck on the validity of the pure tone audiogram (Stach, 1998).

For clinical purposes, speech audiometric measures fall into one of three categories:

- Speech recognition threshold
- Speech awareness threshold
- Word recognition scores

A speech threshold is determined early as a crosscheck for the validity of pure tone thresholds. However, word recognition scores are obtained as estimates of suprathreshold speech understanding (Stach, 1998).

The following section reviews variables which effects speech test, especially speech identification scores. This can be classified under following headings:

(A) Attributes of speech test material

(a) Speech stimuli
(b) Calibration of speech stimuli
(c) Word familiarity
(d) Number of items per list/half vs. full list
(e) Number of lists

(B) Attributes of test recordings and presentation methods

(a) Room acoustics
(b) Signal to noise ratio
(c) Quality of recordings
(d) Speaker selection

(e) Presentation mode
(f) Presentation rate
(g) Presentation level
(h) Carrier phrase

(C) Attributes of scoring
(a) Test administration time
(b) Response method
(c) Scoring

(A) ATTRIBUTES OF SPEECH TEST MATERIALS

(a) Speech stimuli

The types of speech stimuli, used during evaluation, range from nonsense syllables to connected speech.

Nonsense syllables have advantages like it facilitates examination of phonetic errors. Linguistic knowledge does not have an influence and usage of closed set is possible. However, they have poor face validity and evaluation of context is not possible.

In contrast, using words have a higher face validity and it is relatively easy to adopt to closed-set testing, requiring picture pointing responses. The test can be carried out in a relatively short time. Words have the limitation that if the client is unfamiliar with the test items or language, it may influence the test (Thibadeau, 2000).

Sentences/phrases have also been used as speech stimuli. These stimuli are known to have a high face validity. Co-articulation affects are included in the test. Further, evaluation of temporal effects of pauses between words is possible. The disadvantage of these stimuli is that they are influenced by linguistic sophistication and memory (Tyler, 1994, cited in Thibadeau, 2000).

Two major factors influencing selection of material are the patient's age and the purpose of the evaluation. Once the vocabulary level is determined, the purpose of assessment will dictate the materials to be used. If the goal is to determine perception of specific acoustic features, a representative sample of speech sounds that is not influenced by phonemic or syntactic constraints are necessary (Levitt and Resnick, 1978).

When evaluating a patient's ability to use context, speech stimuli that differ in semantic relationships will be needed. To predict real-word performance, ideally the stimuli must have a subset of what the patient will encounter in the real world. Much effort has been spent on developing word lists that are phonetically balanced representative lists of words encountered in English. Recently, the question of whether a sample of single words will be predictive of performance with sentences has been raised. Boothroyd and Nittrouer (1988) and Olsen, Tasell and Speaks

(1997) have shown that the scores on tests of single word recognition are predictive of performance on sentence recognition. Their results support the notion that speech recognition is a generalized skill and that scores on all speech recognition tests are related. Therefore, audiologists may choose from a variety of available speech stimuli to assess speech recognition, but such decisions will be influenced by a trade off between time and reliability.

In general, selection of speech stimuli depends on the purpose of evaluation and age of the patient.

(b) Calibration of speech stimuli

Implementation of a comprehensive calibration procedure for use in speech auditory requires that the clinicians (1) understands the need for specification of the speech signal and related instrumentation in the test environment, (2) adhere to the current standards and (3) develop uniform and functional clinical calibration procedure to ensure the accuracy of speech test results and transfer of clinical information between facilities.

As speech fluctuates in intensity and is difficult to measure in actual sound pressure level (SPL), the calibration level for speech is specified relative to a 1000 Hz pure tone. Hence, "the SPL of a speech signal at the earphone is defined as the rms sound pressure level of a 1000 Hz signal adjusted, so that the vu meter deflection produced by a 1 kHz signal is equal to the average peak vu meter deflection produced by the speech signal" (Rupp, 1980).

The standard reference level for speech as measured with 1 kHz tone is 20 dB SPL for the earphones that are provided with audiometers. Thus, the reference level for speech at 0 dB HL is 20 dB SPL. Less intensity is required to establish speech recognition threshold in sound field listening condition when compared to earphones. However, the calibration values are such that the sound field and earphone testing are equated. In other words, when the audiometer is calibrated properly for the sound field and earphone testing, the average speech recognition thresholds obtained monaurally under phones and in the sound field should be essentially equal, given normal test-retest variability (ANSI, 1989, cited in Wilber, 1994). Dirks, Stream and Wilson (1972) recommended use of speech spectrum noise for calibration of speech levels in the sound field.

In order to ensure the accuracy of measurement being carried out, it is essential the speech material be calibrated as per specified standards. Most recorded material incorporate a 1 kHz calibration signal, prior to each test.

(c) Word familiarity

One factor, based on which there is agreement in selecting test based items, is familiarity. The familiarity of words to the target subjects will have several effects on the difficulty of the speech tests. First, if a test contains a high proportion of relatively unfamiliar words, then the total score will be lower than, if more familiar words had been used. Second, if word familiarity is, on the average, higher in one list than in another, then the equivalence of lists for difficulty will be adversely affected. Third, within a list, the range of familiarity of words will affect the range of difficulty of the items within that lists (Plant and Spens, 1995).

According to Owens (1961), lists characterized by greater familiarity, even to a slight degree, were significantly more intelligible. The less familiar the stimulus, more likely it is to be misidentified (Schultz, 1964). Devaraj's (1983) study on the effect of word familiarity on speech identification scores, carried out on Indian English speakers, is also in consonance with the above studies.

taped stimuli exhibited very similar variability. There was a variability of 6% among half-list and full list scores.

Runge and Hansford-Dunn (1985) recommended using lists that are rank ordered by difficulty and termination of the test after ten words, if no errors occur. The same can be done after 25 words, if there are no more than four errors.

If there is an artifact due to deficiency in the talk back system or the materials are inappropriate for the patient, then it is not likely that 25 more items will solve the problem. In addition, from the standpoint of reliability, scores at the very highest and lowest ends are least vulnerable when administering a half-list (Olsen & Matkin, 1979).

It can be concluded that the choice whether to use half-list or full list depends on availability of time and purpose of the test.

(e) Number of lists used

In clinical practice, one rarely uses several numbers of lists. The need of several lists arises when one has to determine the articulation function of an individual. It is important not to use one list more than once as it will affect the result, due to memory and practice effects (Tillman and Carhart, 1963).

In general, it is recommended that, while constructing tests, the test items should be familiar to the target population. Unfamiliarity with the test stimuli can adversely affect the responses obtained from the subjects.

(d) Half list vs. full list

In an effort to reduce clinical testing time and to avoid patient's fatigue, it has become a common practice for many audiologists to use only a half list, while obtaining speech identification scores. Some authors have advocated its use, others have advised against it and some have recommended its use but with certain conditions. Considerable savings of time can be realized with the half-list procedure, but not without risks. The concern with the use of half-lists is the reliability and validity of the test results. If twenty-five items are given and speech identification scores is high, there is a reasonable expectation that there is no significant artificial adversely affecting performance. In addition, from the stand point of reliability there is relatively little concern that scores will become poor on last twenty-five items (Silman & Silverman, 1991).

Half-list and full list speech identification scores were analyzed for both taped and Monitored Live Voice (MLV) presentation modes. It was found by Beattie, Shivhonec & Edgerton, 1978 that both the MLV and

In order to over come the effects of memory and practice, it is recommended that equivalent list be used. In such a case, no item will be presented more than once. The greater the number of equivalent list available, the more flexible the test will have (Dillon and Ching, 1995).

It is also important that each list should be comparable with the other. That is, the items in each list should be identical with respect to difficulty (Hood and Poole, 1977). If two lists do not meet these criteria, then the scores obtained by each of them will not be comparable.

Malani (1981) studied the inter-list differences using form A of NU 6 on Indians. There was no significant difference between the lists at higher sensation levels.

It is also not uncommon to see tests having just one list (e.g., (Auditory Rhyme Test, Fairbanks, 1958, cited in Dillon and Ching, 1995), 4 lists (CIDW-22 lists, Hirsh, Davis, Silverman, Reynolds, Eldert and Benson, 1952, cited in Dillon and Ching, 1995). However, there exists as many as 10 lists (Lehiste, Peterson CNC lists cited in Malini, 1981), 20 lists (e.g., PAL lists of PB 50, Egan, 1948, cited in Dillon & Ching, 1995).

(B) ATTRIBUTES OF TEST RECORDINGS AND PRESENTATION METHODS

(a) Room acoustic and reverberation

According to Nabelek and Nabelek (1994), reverberation is the persistence of sound in an enclosed space resulting from sound reflection within that space. Reverberation time is the time which is required for the mean square sound pressure level, originally in steady state, to decrease to 60 dB after the source stops (Nabelek and Robinette, 1978).

In a room with a reverberant time of 1-2 msec on even 0.4 msec, the reflected energy may change some of the important aspects of a speech signals and interfere with speech intelligibility by producing a distortion of the original signal (Houlgast and Steemeken, 1972, cited in Ross and Gjjolas, 1971).

Roller and Crum (1974) examined the combination effects of reverberation, noise and distance from the speaker on monosyllabic word intelligibility, of normal hearing adult listeners. In the quiet environment condition only the prolonged reverberation time of 1-2 sec reduced intelligibility and the combination of noise, reverberation and distance interacted to reduce performance more than could be predicted by summing the effects of each variable in isolation (cited in Flinitzo-Hieber and Tillman, 1978).

There is a complete integration of the reverbrance or reflected sound with the direct signal upto about 30 msec and at least partial integration between 30 and 80 msec (Lochner and Berger, cited in Finitzo-Hieber and Tillman, 1978).

People with normal hearing require an S/N ratio of +6 dB for reception of intelligible speech. It is well established that in the presence of noise with normal hearing and hearing impaired individuals have difficulty in understanding speech (Ross, Huntington, Newby and Dixon, 1965; Olsen and Tillman, 1968).

Therefore, in general speech testing should be carried out at appropriate room situations and noise level.

(b) Signal-to-noise (S/N) **ratio**

In general, the intelligibility of speech materials falls along a continuum of difficulty based on the meaningful information in the utterance. The more information there is, the steeper the performance intensity (PI) function. Four syllable words are more intelligible than two syllable words and so on. The PI function varies depending on signal to noise ratio (Hirsh, Reynolds and Joseph, 1954).

The variations occurring due to the presence of noise are also influenced by the type of hearing loss. As the S/N ratio becomes less favourable, the effects on speech discrimination scores are more pronounced for sensory neural hearing loss subjects than for normally hearing subjects (Olsen and Tillman, 1968).

Not only will the S/N ratio be a factor but the type of masking noise used has been shown to affect performance (Lovrinic, Burgi and Curry, 1968, Williams and Hecker,1968) and Garstecki and Mulac/1974).

Lovrinic, Burgi and Curry (1968) observed marked poorer performance in the presence of ipsilateral noise. Findlay (1976) compared speech identification in the presence of speech spectrum noise and 'cocktail party'. Speech identification scores were more depressed for the hearing impaired subject under both condition.

The rationale for mixing some background competition is twofold. First, it makes the test more difficult. Second and more important, speech communication in everyday life situations most commonly takes place against background competition of some sort. Therefore, the tests administered for assessing an individual's ability to hear and understand speech should include background noise or speech competition as well.

The presentation of other test materials against a background of noise or other speech, enhances the sensitivity of the test in detecting and demonstrating communication difficulties experienced by hearing-impaired individual (SURR and Schucartz, 1980).

In general, it can be concluded that the test should be performed at high S/N ratio. However, depending on the purpose of the test, some competition noise may be given.

(c) Quality of recordings

For tests that deposit adequate standardization **information, these** data are typically provided for a particular recording of the test. Many tests are now produced and commercially distributed by companies. In some cases, these companies may rerecord the test items for any particular test. Unless additional standardization data are provided with these re-recordings, the tests may again be altered enough to make these rerecorded versions different from the original unless comparison data are provided to prove otherwise (Mendel and Danhaaver, 1997).

However, for the rerecording of test stimuli, caution also should be exerted regarding the quality of commercially produced tapes. Initially, many tapes have exhibited cross talk, echoing of the stimuli, and unacceptable levels of tape noise between stimulus presentations. Obviously high quality tape recordings are preferred. Today, many of the word lists are being rerecorded onto CDs to improve the quality of test tapes, and some audiometers and computer programs actually produce digitized versions of various speech signals that are stored in the system or generated on line. These forms of stimuli are state-of-the-art and offer considerable variety and the flexibility over traditional disc and tape recordings. The fact that they can be digitized from almost any analog source, however, means that a different talker or type of background noise could be used for different presentations, and again, comparison data should be provided to show that no significant differences in test scores exist between these new recordings and the original analog tapes. Otherwise, similar comments made about monitored live voice testing also would be true for these stimuli produced using advanced technology (Mendel and Danhauer, 1997).

Hence, it is evident from the above literature, that digitized recordings have substantial advantage over analog recordings and are used extensively now.

(d) Speaker selection

Speaker selection is one of the important variables which may affect speech identification testing. The linguistic background, familiarity, hearing acuity, attention, fatigue of the speaker are significant variables (Merell and Aktinson, 1965, Markides, 1978).

Poor performance in speech intelligibility task was seen, when lists were spoken by more than one speaker (Creelman, 1957). It is reported that latencies to be faster for words in single speaker than words in multiple talker condition.

Brandy (1966) showed that even a single talker's repetition of a monosyllabic word list (C10-2 W22s) under monitored live voice condition introduced variability in suprathreshold speech recognition scores.

The identification scores were always better for words that are produced by a single talker than for words produced by multiple talkers. Trial-to-trial variability in the speaker's voice affected recognition performance. The perceptual system engages in some sort of adjustment each time a new voice is encountered during the set of trials using multiple voice (Creelman, 1957; Peters, 1955, cited in Pisoni, 1992).

Kreul, Bell and Nixon (1969) reported that the scores for repeated testing for either of the two talkers on different occasions are not significantly different. Hence, it can be concluded that, speech tests should be performed with minimum talker variability.

(e) Presentation mode

A lot of controversy exists as to whether recorded or monitored live voice test (MLV) materials should be used for speech audiometry. According to Carhart (1965), Kreul, Bell and Nixon (1969) and Northern and Haltter (1974) recorded materials are preferable to maintain consistency in presentation especially for research testing. Creston, Gillcspic and Krohn (1966) and Resnick (1962), on the other hand, argue that results obtained from different talkers cannot be compared unless the talkers have been demonstrated to be equivalent. They favour MLV presentation and point out that, it provides the examiner greater flexibility over the environment. In addition, it requires shorter time for test administration because the tester can control the rate of stimulus presentation. Also, with pre-recorded test materials, each talker's unique characteristics are permanently built into the test that is recorded. Thus, there may be as much difference between one recording and another, as between two live voice talkers (Carhart, 1965).

This issue of each talker's characteristics being built into the recordings can be addressed from another perspective. That is, the level of difficulty of the test is determined partly by the talker's characteristics (e.g. gender and dialect). It is believed that women's voices are generally softer, higher pitched and thus harder for some patients to hear than men's voices (Mendel and Danhauer, 1997). A study done in India by Joseph (1983) found that female talkers were more understandable than male. However, the level of test difficulty remained consistant with a recorded version, assuming that the recording is used with similar type of equipment calibrated to same standards.

A survey of clinical practices by Martin and Pennington (1971) indicated that MLV procedures were being used in the majority of busy clinical settings (cited in Kruger and Mazor, 1987). Similar findings were found in 1994 during the updated survey by Martin, Armstrong and Chemplin.

The American Speech-Language Hearing Association (1988) recommended that either MLV or recorded procedures could be used but recorded materials are preferred (as cited in Silman and Silverman, 1991). The use of MLV testing raises questions about the sensitivity of a speech recognition test, when the standardized information collected on the test has been obtained using recorded versions of the stimuli.

The recording on tape recorder can be available on analog or digital tapes. Often when testing speech intelligibility, playback of the test stimuli from analog tapes causes troublesome measurement, since analog tapes are quiet sensitive to ambient conditions. Therefore, complete control of the set up, including calibration of the signal levels would be necessary before each test performance. Otherwise, it would lead to unreliable results. Furthermore, if experiments have to be repeated for different orders of presentation, it has to be done by recording the test stimuli on tape in different orders. It is also difficult to arrange adaptive presentation of a test in a simple way (Mendel and Danhauer, 2000).

The limitations of analog recording can be overcome by digitized recording which can be through compact discs (CD) or computers.

The advantages of using compact discs as mentioned by Kamm, Carterette, Morgan and Dirks (1980) are:

1. High fidelity recording with enhanced signal to noise ratio
2. Virtually infinite channel separation and no point through
3. Identical recording from one disc to another

4. Recording medium that rarely deteriorates as a function of use and time, and therefore, seldom needs replacing
5. Almost instantaneous access to any one of 100 tracks (i.e., no winding or rewinding to access a particular word list)
6. 144 minutes of recorded materials per disc
7. Offers an extremely favourable quality ratio (Wilson, 1997, cited in Mendel and Danhauer, 1997)

Apart from these, there are also some useful features of CD players used in auditory evaluation. These include, (a) random tract selection, (b) display of track and time remaining while playing, (c) channel segment define and play, (d) remote control facility and (e) variable output level.

However, there are also some disadvantages of using audio CDs, such as, occasionally a good CD may go bad. This can be manifested as either a decrease in the signal-to-noise ratio. Another disadvantage is that the CD player may not access the requested track.

In the future, the audio CD may be a focal point of audiological evaluations and rehabilitation, as well as a rich source of information and demonstration material for educational purposes. All signals used in audiological evaluation can be stored on the disc including pure tones, narrow band noise and speech materials at the required levels.

The more sophisticated auditory facility with the future will generate and deliver online signals needed in the course of an audiological evaluation. Regardless of this digital technology should simplify greatly the instruments used by audiologists in the future (Wilson, 1997, cited in Mendel and Danhauer, 1997).

Moog and Geers (1990) recommended the use of computerized speech tests, which take into account, the advantages of both live and recorded voice testing.

The great advantage of a computer over a tape recorder based system is its flexibility. Campbell (1974) has listed the advantages of using computer based speech audiometry as follows:

1. Digital representation of speech signals do not deteriorate over time
2. Sophisticated alterations such as time compression can be made relatively easily
3. Inter-laboratory consistency will improve substantially
4. Control over stimulus presentation can be enhanced

5. Test-retest reliability comparisons within the computer threshold reveals high correlations
6. Stimulus presentation can be easily randomized by the computer (Stach, 1988).

The speed at which a conventional test is performed is largely determined by the timing of words as they are recorded on the tape. This has to be chosen in such a way that it is suitable for the average patients. It should not be too fast for those who find the test difficult or too slow, for those who could cope with a faster pace. It is very simple to arrange for a computer to repeat words on demand, to present the test words only when a response has been made for previous item and to adapt to preferred pace of the patient (Martin, 1994). With only one copy of the test material on a disc, software can arrange for the test stimuli to be played back in a different order in every new test session (Keidser, 1991).

Stach (1988) reported, two major disadvantages of microcomputer based systems. These include: (a) personal or professional choice may be limited, (b) they often require substantial initial capital outlay. An integrated system is necessarily expressive and the cost/benefit ratio requires careful considerations.

There are also studies, which compare live voice testing with recorded testing. Moog and Geers (1990) have reported poorer test-retest reliability scores for live voice stimuli (0.5 to 0.62) than for the recorded stimuli (0.84 to 0.93). However, Geers (1994) reported that an important consideration in selecting a speech perception test is the availability of stimuli for recorded presentation.

Thus, it can be concluded that the presentation mode depends on the availability of instruments. If computers are available in the clinical set up, t is the best choice for testing as it incorporates the advantages of both live voice and recorded presentation. No study has reported a comparison of responses when the signals are presented through CD or computer.

(f) Rate of presentation

Presentation rate is another important variable which affects test administration time and in turn speech identification scores. According to Miller (1981) changes in speaking rate alter the perception and categorization of signals.

Sommers, Nygaerd and Pisoni (1994) reported that speech recognition scores were better for constant rate of speech than for varying rate of speech. This was attributed to increased acoustic-phonetic variability which resulted in poorer scores. Similar findings were reported earlier by Mullenix, Pisoni and Martin (1990). Johnson and Strange (1982) have also suggested that correct information about articulation rate is necessary to compensate for the incomplete acoustic specification, which may occur at faster rates.

In general, it can be concluded that speech recognition scores were better for constant speaking rate when compared to variable rates.

(g) Presentation level

Depending on the purpose of a speech recognition assessment, the stimuli may be presented at a level equal to the level that of average conversation, the most comfortable listening level for the patient or at a level necessary to achieve maximum performance. For the purpose of differential diagnosis, several presentation levels may be necessary to determine, which one affords the patient the maximum opportunity for clear recognition and to determine whether performance declines with increased intensity.

Evaluation of speech recognition at several intensity levels is referred to as a performance intensity (PI) function. The shape of the PI function is unique not only for a given patient but also for the type of material used. The function for sentences is the steepest where each dB of intensity results in approximately 10% increases in recognition. However, for words each dB results in about a 4% increase. By obtaining a PI function, audiologists can determine the maximum performance for each patient, referred to as the PB max, when phonetically balanced monosyllabic word lists are used (Thibadeau, 2000).

However, it is often not clinically feasible to evaluate speech processing at several intensity levels. Therefore in an attempt to achieve PB max and determine whether rollover is present, testing may begin at a high level such as 80 dB HL or at 30 dB SL with reference to SRT. If the 80 dB HL level is adequate, and the measured score is 84%, or higher when a half-list is used, further testing to determine PB max is not necessary. The reason is that even if the maximum possible score of 100% was obtained at a lower intensity, the difference score of 16% is less than the 20% criterion difference to be considered rollover (Jerger and Jerger, 1971).

When a score of less than 84% is achieved, it could mean either that a higher presentation level is needed to achieve PB max because of reduced audibility of the signal, or a lower presentation level is needed because the score reflects rollover.

The decision to present a second list at intensity level above or below 80 dB HL will be determined by the pure tone average (PTA). If the PTA is above 40 dB HL, it is likely that a higher presentation level is necessary to achieve PB max because the Articulation Index (AI) predicts that the entire spectrum may not have been audible at 80 dB HL. However, if the PTA is less than 40 dB HL, the AI predicts that the speech information should have been audible and a lower presentation level which would determine if the score was suggestive of rollover (Thibadeau, 2000).

Clinically the most commonly used sensation levels are 25 to 40 dB SL (Martin and Sides, 1985). 25 dB SL corresponds to the beginning of the plateau at which normal hearing subjects attain scores of 90% or better, and 40 dB SL represents a reasonably comfortable listening level for normal hearing persons.

Abrol (1971., Ghosh (1988) and Mathew (1996) and Vandana (1998) observed maximum speech identification scores at 30 dB SL for Hindi, Bengali, Malayalam and Kannada respectively. Kapur (1971) observed the similar results with Tamil at 35 dB SL. Speech identification test in English for Indian population was conducted by Swarnalatha (1972), Mayadevi (1974) and Rout (1996). They obtained best scores at 30 dB SL, 33 dB SL and 30 dB SL respectively.

From the above review, it can be construed that it is always preferable to do testing at 30-40 dB SL to obtain better speech identification scores.

(h) Carrier phrase

Another variable that may affect speech identification scores is the use or omission of a carrier phrase. Typically during speech identification testing, carrier phrase precedes the stimulus words.

Egan (1948, cited in Silman and Silverman, 1994) felt that the carrier phrase was necessary to alert the patient to the fact that the test word was to follow. The carrier phrase also assists the talker in monitoring the speech intensity to the appropriate level on the vu-meter. Generally, the carrier phrase is spoken with sufficient effort to cause the desired deflection on the vu-meter. The test words are then spoken with the same effort as the carrier phrase, but, without concern as to whether the test items cause the same deflection or not (Olsen and Matkin, 1979).

According to Egan (1948, cited in Silman and Silverman, 1994) if the test item is presented with constant interstimulus interval, it is sufficient to alert the patient that the test item is forthcoming. However, Martin and Fobis (1978, cited in Rupp, 1980) said that the use of carrier phrase in clinical practice may be on the wane. Martin, Hawkins and Bailey (1962) found no significant difference in the identification of words recorded in isolation and words recorded with carrier phrase.

Studies done by others have not obtained identical results. Gelfand (1975) and Gladstone and Siegenthaler (1972) have reported slightly poorer score for word recognition test administered without a carrier phrase than with the carrier phrase.

It has been suggested by Lynn and Brotman (1981) that a carrier phrase may actually contribute to intelligibility of test words when the acoustic cues important for identification of certain phonemes are studied.

The issue of whether to use the carrier phrase or not is presently unresolved. One factor in determining when to use a carrier phrase may be determined by whether the test is presented by recording or monitored live voice (Mendel and Danhauer, 2000).

From the above studies, it may be inferred that it is not essential to use a carrier phrase if the signals are being presented at constant intervals. However, if the intervals between signals is not constant, it would be better to use a carrier phrase. The constant interval would usually be seen in recorded material and not in MLV. Hence, it may be advisable to use a carrier phrase while using monitored live voice testing.

(C) ATTRIBUTES AFFECTING SCORING

(a) Test administration time

Another consideration in the development and administration of speech perception materials is the amount of time needed to administer and score them. Many tests, especially test batteries, require a considerable amount of time for the presentation of stimuli. The length of time needed for test administration generally is a function of,

(i) number of stimuli presented
(ii) length of the stimuli
(iii) interstimulus interval
(iv) subject response time
(v) difficulty of the stimuli
(vi) fatigue and frustration
(vii) large number of patients seen in a short period of time.

Generally, the more unsure the individual is of the stimulus, the longer will be the response time. The more similar the stimulus is to its foils, the greater the hearing loss on the competing background noise, the more difficult the decision process is for the subject. Measuring response time, as in choice-reaction time judgements, can offer considerable information regarding the confidence of a subject's response. Test administration time is also an important factor in clinical situation where a large number of patients are seen in a relatively short period of time (Mendel and Danhauer, 1997).

The examiner's experience is an important factor in order to recognize when tradeoffs between test time and patient's fatigue are appropriate. He must be aware of how factors that influence subject's test result in research paradigms can affect a particular patient's clinical performance under similar situations (Mendel and Danhauver, 1997).

Thus, the test administration time will depend on a patient's state of mind and the purpose of the test. The number of items in the test will also determine the total administration time.

(b) Response set

The variety of test materials used in assessing speech can be divided into two general types of response formats: open set and closed set. In an open set or free response formant, the stimulus is given without any specified alternatives. This formant allows the listener to choose among an unlimited numbers of possible responses. For this, response options exist such as repeat the stimuli orally, write the stimuli on paper or type the stimuli on keyboard. Closed set tests, on the other hand, restricts the listener to one of a fixed number of possible responses (Mendel and Danhauver, 2000).

The advantages of open set tests are that they include more flexibility. A lack of a written answer form provide an unlimited number of alterations, so that, individuals can use linguistic and auditory factors to help them perceive the test item. Additionally no guessing floor is present in open set tests, that can boost scores (Black, 1957). Other proponents of the open set format are Corso (1967) and Miller, Heise and Luchlen (1958, cited in Penrod, 1994). Another advantage of open set tests is that the test items can be easily randomized (Mendel and Danhauer, 2000).

There is a chance factor inherent in the closed set testing paradigm and thus, it limits the range of useful scores. In open set testing, however, the usual range is 0-100%.

The selection of which response formant is to be used is important with respect to the known advantages and limitations of the method. Users of the test should be made aware of the kinds of information the test can supply accurately, as well as those it cannot provide. If the users of the tests are unaware of the inherent limitations, inaccurate conclusions may be drawn from the test results. Consequently, the sensitivity of the measure may be in question. In addition, changing the format of a test from its original mode may also change the test and affect its sensitivity (Thibadeau, 1997).

The distinction between open and closed response sets becomes blurred when the 'closed' response set actually includes all the items that would be possible in an open response set (Dillon and Ching, 1995).

The review, suggest that closed set response provide high scores in case of children. For adults, open set response is preferable.

(c) Scoring methods

The method of scoring subjects responses on any test of speech perception is an important consideration in the administration of the test and in the interpretation of its results. Several types of scoring methods are available, and the amount of information obtained from each depends on the type of test used. For example, in open set testing paradigms, listeners are typically required to repeat the stimulus heard.

The subjects' scores, then, are a function of their responses as well as the examiner's auditory perception and interpretation of them. This can be particularly difficult if a subject has impaired speech quality, impaired articulation or both, such as in the case of deaf speech (Mendel and Danhauer, 2000).

Research investigating the accuracy of examiners perceptions of subjects' responses has generally shown that an average of 16% to 20% of the responses were scored in error. The errors were most commonly in the direction of accepting responses as correct that were in fact incorrect (Merrell and Atkinson, 1965; Nelson and Chaiklin, 1970). When examiners have a list of the stimuli before them and use it to check off the subject's responses as correct or incorrect, the examiners frequently anticipate the subject's responses and may award credit when in fact an error was made. In this case, the lack of diligence in recording subject's responses can lead to inaccurate and inappropriate estimates of the subject's speech perception abilities. Problems are also noted when the examiner and the subject do not share the same language or dialect.

There are ways to keep such errors from occurring. These methods often require a bit more attention and diligence on the part of the examiner and the monitoring equipment, but the trade off is worth the effort to be sure that accurate data is being collected. The accuracy of an examiner's recording of a subject's response in an open set paradigm can be improved by having the examiner use visual and auditory cues while recording responses from the subject (Lovrinic, Burge and Curry, 1968). The subject can use written, oral, or manual communication as different response forms to increase the accuracy of the examiner's recording.

The reliability of the examiner's recording of the subject's responses is also a critical variable. Since subject's scores are a function of the examiner's ability to record the responses correctly, additional examiners should record the responses as well. Other judges may transcribe and score the subject's responses online, that is, at the same time the primary examiner is recording responses; or offline, using an audio or videotape recording of the subject's responses. This process is known as interjudge scoring reliability. Also, intrajudge scoring reliability may be completed where the primary examiner records and re-scores the subject's responses from audio or video tape offline. Both inter- and intra-judge scoring reliability should be high and are important in any scoring method.

The goal of the examiner should be to acquire an accurate picture of the subject's speech perception abilities (Boothroyd, 1968; Edgerton and Danhavuer, 1979, cited in Dillon and Ching,1990).

Although it should go without saying that both intra and interjudge scoring reliability are desirable, it soon becomes obvious to the clinician working alone in private practice, or in most other clinical situations, that these procedures require additional time, technology and personnel that usually are not available. In such cases, reliability in scoring is no less important than in the controlled research setting.

In speech recognition testing where listeners repeat the stimulus heard, the stimulus can be scored by using synthetic (all or none) scoring procedures by analytic-type procedures, such as phoneme scoring (Mendel and Danhauer, 1997).

In phoneme scoring procedures the awards credit for each phoneme, if the stimulus is perceived correctly. In all or none scoring procedure, the experimenter may choose not to transcribe the subject's response, but rather may simply check off right or wrong on a printed list of the response items (Thibadeau, 2000).

Analytic scoring methods may increase the sensitivity of tests by providing a more informative profile of listener's speech perception abilities than is available through all or none procedures.

Thus, it is evident from the literature that it is important to consider which scoring method is to be used when determining the speech perception testing. The interpretation of the test may vary depending on the scoring procedure used.

The review of literature brings to light that there are several variables that affect speech identification. These variables would differ depending on whether the test is administered on adults or on children.

The first part of review discussed the attributes of speech test, which should be considered by the examiner before opting for the test. The second attribute is recording method and presentation. Among these, their variables are discussed which would affect recording and presentation of test material. The last attribute i.e., scoring should be seen after the outcome of the results. All these variables should be kept in mind while constructing or administering a speech identification test.

METHOD

The aim of the present study is to compare the two different ways of presenting speech material to adults through a computer and through a compact disc.

Subjects: Fifty adults comprising of twenty-five females and twenty-five males were taken. The subject met the following criteria:

1) Were fluent in Kannada
2) Were in the age range of 18-30 years
3) Had normal speech and hearing
4) No history of neurological or otological problem

Test material:

Bisyllabic phonemically balanced word list in Kannada, developed by Vandana (1998) was used. The test contains two lists with fifty words each. Each list has two equal half-lists (twenty-five words). In the present study, each variable was tested using a half list.

Instrumentation:

A computer with AudioLab software (16 Bit Mono 32000 Hz 63 KB/S) was used to record the speech material. The material was then transferred to a digital tape recorder (Sony portable Mini Disc Recorder MZ-R70) from which the material was transferred to a compact disc (CD) using a CD writer.

The audiological testing was carried out using a two channel clinical audiometer (Madsen OB822), coupled to acoustically matched earphones (TDH-39) with MX-41R ear cushions and a bone vibrator (Radio ear B-71). The audiometer was calibrated to confirm to ANSI (1992) standards. The speech material from the computer or CD player (Philips) was routed through the audiometer to earphones.

Test Environment:

Testing was carried out in a sound treated double suit. The ambient noise was within permissible limits, as recommended by ANSI (1991).

Recording of test material:

The test material was recorded into a computer using a AKG D-75 microphone. The recording was done in a sound treated room by a female native Kannada speaker. The computerized material was scaled using the AudioLab software so that all the words were of similar intensity. Before each list, a 1 kHz calibration tone was recorded. A batch file was created with an inter-stimulus interval of four seconds. The material was then transferred to a digital tape recorder from which it was again transferred to a CD using a CD writer.

Procedure:

a) Pure Tone Testing:

To ensure that the subject had normal hearing, pure tone testing was done. Pure tone thresholds for air conduction and bone conduction were obtained for the frequencies from 250-8 kHz and 250-4 kHz respectively. The better ear was considered as the test ear for evaluation of each subject.

b) **Speech Recognition Threshold Test:**

Speech Recognition Threshold (SRT) was established using the Kannada paired words developed by Rajashekar (1976, cited in ISHA Battery 1990). Testing was done using the procedure suggested by Carhart (1971). The minimum level at which the subjects could respond to 50% of the items presented was considered as the SRT.

c) **Speech Identification Scorer:**

Instruction: Subjects were instructed in Kannada to repeat the words that they heard.

Test administration:

The recorded material was presented either through the CD player or the computer. Half the subjects listened to the CD player material first and the other half the computerized speech material.

Initially three practice items were presented at a comfortable level i.e., 40 dB SL. Each subject was tested at two intensity levels i.e., 30 dB SL and 40 dB SL with reference to the speech recognition threshold.

It was ensured that no list was repeated per subject. All subjects listened to both the intensities as well as both presentation modes (computer and CD). The variables were randomly presented.

The inter-stimulus interval was four second for CD material. For the computerized material, it varied depending on the pace at which the subject responded and this time was noted.

The testing was done after a month on twenty subjects consisting of ten males and 10 females. These subjects were part of the initial testing. During this testing, computerized material was presented using an inter-stimulus interval of four seconds. This was done to compare the effect of manual vs. automatic presentation and rule out the variability due to the use of different instruments.

Scoring:

Responses were recorded in a score sheet. Each correct response was given a score of one and incorrect response a score of zero. In addition, the time taken for the subjects to carry out the test, when the material was presented through the computer with variable inter-stimulus interval, was noted. The data collected was subjected to statistical analysis.

RESULTS AND DISCUSSION

The study was carried out to obtain the effect of two-presentation mode of speech identification scores on adults. The comparison was done using the 't' test for the following.

(a) at two intensity levels

- (i) between two modes (CD and computer)
- (ii) within two modes

(b) Male vs. female

(c) Across fixed vs. variable interstimulus interval

(a) **Comparison across two intensity levels**

The test material was presented using a CD and computer on 50 adults. The test was administered at two intensity levels i.e., 30 dB SL and 40 *dB* SL relative to speech recognition threshold.

(i) <u>Effect of intensity levels between two modes of presentation</u>

Mean and standard deviation for the speech identification scores were computed at the two intensity levels i.e., 30 dB SL and 40 dB SL. This was done for two presentation modes (computer and CD). The paired 't' values were also calculated for the above variables and is tabulated in table 1.

Table 1. Mean, standard deviation and t values at two intensity levels between two modes of presentation

Variable	Mean	Standard deviation	t values
30 CD	24.18	0.9409	3.53**
30 C	24.7	0.5803	
40 CD	24.18	0.262	1.45 NS
40 C	24.86	0.3505	

** significant at 0.01 level.
NS - not significant at both 0.01 and 0.05 levels.

The results show that there is a significant difference when the material was presented through computer and CD when the signal was presented at 30 dB SL. Though the mean values between the two modes hardly varied, the standard deviation was more for the signals presented through the CD. This probably occurred to on account of the lesser clarity of the signal presented through the CD, at the lower intensity (i.e., 30 dB SL). However, at the higher intensity level (40 dB SL), no such difference was observed. So, it can be concluded that instrumentation plays a role at lower intensity level but not at a higher intensity levels.

(ii) The effect of presentation level on speech identification scores within two modes.

The test materials that were administered at two intensity levels (i.e., 30 dB SL and 40 dB SL) relative to SRT through both CD and computer were compared within each mode of presentation. The mean, standard deviation and paired 't' values were obtained (Table 2).

Table 2. Mean, standard deviation and t-values at two intensity levels within each presentation mode

Variable	Mean	Standard deviation	t values
30 CD	24.18	0.9409	ONS
30 C	24.18	3.262	
40 CD	24.7	0.5803	1.45 NS
40 C	24.86	0.3505	

The results show that there is no significant difference when the material was presented at two levels, within each mode. This was true when the signals were presented either through the CD or computer.

The findings in the present study are in good agreement with studies done in western countries (Tillman (1963) and Carhart (1965) and also in India (Abrol (1971), Mathew (1996), Swarnalatha (1972) and Vandana (1998). These investigators have obtained maximum scores at 30 dB SL. With further increase in intensity, they too did not find an improvement in scores.

As there is no difference at the two sensation levels, speech identification testing can be done at 30 dB SL or 40 dB SL. For individuals with severe hearing loss, where maximum audiometric limit will not permit the test to be carried out at 40 dB SL and for subject with reduced uncomfortable loudness level, the test can be carried at 30 dB SL.

(b) The effect of sex difference on speech identification score

The mean and standard deviation were calculated for the 25 males and 25 females who were part of the study. The speech identification scores were compared between them for the two presentation modes i.e., CD and computer. The analysis was also done at two intensity levels i.e., 30 dB SL and 40 dB SL. The paired t-values were calculated to check for significance of difference between means (table 3 and table 4).

Table 3. Mean and standard deviation across presentation mode and Intensity levels in males and females

	CD				Computer			
Variables	30 CD	40 CD	30 CD	40 CD	30 C	40 C	30 C	40 C
	Mean		Standard deviation		Mean		Standard deviation	
Males	24.16	23.72	0.9434	4.56	24.72	24.84	0.542	0.3742
Females	24.16	24.64	1.0279	0.7	24.68	24.88	0.6272	0.3317

Table 4. t-values across presentation mode and intensity levels in males and females

Variables	t-values for males	t-values for females
30 dB SL & 40 dB SL CD	0.458	1.853
30 dB SL & 40 dB SL C	0.827	1.3
30dBSLC&30dBSL CD	2.682*	2.397*
40 dB SL C & 40 dB SL CD	0.827	2.009

* significant at 0.05 level

The results show that in both males and females, there was a significant difference at lower sensation level i.e., 30 dB SL when presented through CD and computer (table 4). At this intensity level, both males and females obtained slightly lower mean scores and the SD was higher (table 3). This can be because of the lesser clarity of signals when presented through CD.

The speech identification scores were also compared between males and females for two presentation modes and two intensity levels using independent t-test (table 5).

Table 5. t-values comparing sex differences for two modes and intensity levels

Variables	T values males vs. females
30 CD	0.149*
40 CD	0.419*
30 C	0.241*
40 C	0.4*

* not significant at both 0.05 and 0.01 levels

The above results show that there is no difference between males and females for the above variables. This shows that both males and females process speech signals in a similar way.

(c) The effect of interstimulus interval on speech identification scores

(i) The speech identification scores presented to the 20 subjects at a constant and variable interstimulus interval, through the computer were compared using the 't' test. The constant interstimulus interval of 4 seconds was used. The variable interstimulus interval, varied depending on pace at which the individual responded. The mean, standard deviation and paired t-values are given in table 6.

Table 6. Mean, standard deviation and t-values of speech identification scores having constant (Auto) and varying (Manual) inter-stimulus presentation

Variables		Number	Mean	S.D.	t values
30 C	Manual	20	24.85	0.3663	0.698
	Automatic	20	24.75	0.5501	
40 C	Manual	20	24.95	0.2236	0
	Automatic	20	24.95	0.2236	

The results show that there is no significant difference in the scores for the above two presentation.

Contrary to the findings in the present study, Mullenix and Pisoni (1990, cited in Sommers, Nygaord and Pisoni, 1994), Sommers, Nygaord and Pisoni (1994) reported that when test items are presented at a single speaking rate, better identification scores are obtained at higher S/N ratios. In the present the subjects obtained almost equal scores when the, interstimulus interval was varied or kept constant.

Hence, with adults the signals can be presented at a constant or variable interstimulus interval without there being any detrimental effect on the speech identification scores.

(ii) The test administration time for manual presentation at 30 dB SL and 40 dB SL was also computed using the mean, standard deviation and paired 't' test (table 7).

Table 7. Mean, standard deviation and t-values for administration time at varying and constant interstimulus interval

Variables		Mean	S.D.	t values
30 C	Manual	44.96 sec	5.8	5.735**
	Automatic	108	0	
40 C	Manual	44.6 sec	6.6	6.8**
	Automatic	108	0	

From the above results, it is evidence that there is a statistically significant difference in time taken for the test carried out at a constant and variable interstimulus interval. The subject took less time for the manual presentation of stimuli. So, for adults manual presentation can be used as it takes less administration time.

In conclusion, the findings of present study can be summarized as follows:

1) The computer is better compared to CD for obtaining speech identification scores at lower intensity level i.e., 30 dB SL. However,

at higher level no difference is seen between the two presentation modes. Hence, the signals can be presented through either mode at 40 dBSL.

2) The speech identification scores can be obtained at 30 or 40 dB SL, as there was no difference in scores at these intensity levels, when the same mode of presentation is used.

3) No difference in scores was obtained between males and females for both presentation mode (CD and computer) and intensity levels (30 dB SL or 40 dB SL).

4) In adults, there is no difference in the score of manual (variable interstimulus interval) and automatic presentation (constant interstimulus interval). Hence, either can be used.

5) Test administration time is significantly different for 30 dB SL and 40 dB SL for manual presentation and automatic presentation mode. So, it is recommended to use manual presentation in case of adults if the test is to be administered faster.

From the above findings, it is recommended that —

(a) The stimulus is to be presented through the computer if the signal is to be presented at lower sensation levels (i.e. 30dBSL).

(b) At higher levels of presentation (i.e. 40 dB SL) the signal can be prescribed either through the computer on the CD.

(c) If the test is to be administered faster, the stimuli may be presented through the manual mode of the computer, where the interstimulus interval can be varied.

SUMMARY AND CONCLUSION

Research carried out by several investigations have shown that there are considerable advantages of using recorded speech when compared to live voice, for audiometric purposes (Rupp, 1980; Fuller, 1987). Also, the digitized recording is preferable over analog recording because of its several advantages (Wilson, 1997).

The present study was carried out to compare speech identification scores using two presentation modes i.e., computer and compact disc presentation in adults. This was done to see if either a computer or a CD could be used for estimation of speech identification scores.

Fifty subjects (twenty-five males and twenty-five females) were taken who were fluent in Kannada. They were in the age range of eighteen to thirty years. None of the subjects had a history of any otological and neurological involvement and they had normal speech and hearing.

Speech identification scores (SIS) were obtained using the bisyllabic phonemically balanced word list in Kannada, developed by Vandana (1998). The scores were obtained through computer as well as CD. This was done at two intensities - 30 dB SL and 40 dB SL, with reference to SRT. The following comparison was made with the data collected:

1. SIS between two presentation modes at two intensity levels.
2. SIS within two presentation mode at two intensity levels.
3. SIS of males and females.
4. SIS for fixed and variable interstimulus interval.
5. Comparison of test administration time at fixed and variable interstimulus interval.

The data obtained was analyzed using mean, standard deviation and t-test. The results revealed the following.

1. There was no difference in speech identification scores for two recorded presentation modes (CD and computer) at 40 dB SL. However, at 30 dB SL, scores through the computer were better than that obtained through CD.
2. There was no difference in scores obtained at 30 dB SL and 40 dB SL when same mode of presentation was used. Hence, 30 dB SL can also be used to obtain speech identification scores in adults, if required.
3. When a fixed interstimulus interval or a variable interstimulus interval was used, there was no difference in the speech identification scores. However, subjects responded significantly faster when a variable

interstimulus interval was used. The test could be done at almost less than half the time when the variable interstimulus interval was used.

4. For males and females, there was no significant difference across both presentation mode and presentation level.

From the above findings, it is recommended that,

(a) The stimulus be presented through the computer if the signal is to be presented at lower sensation levels (i.e., 30 dB SL).

(b) At higher levels of presentation (i.e., 40 dB SL), the signal can be presented either through a computer or the CD.

(c) If the test is to be administered faster the stimuli may be presented through the computer using the manual mode where the interstimulus interval can be varied.

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APPENDIX -1

TEST LISTS (Given by Vandana 1998)

Familarization items:-

ಮಂಚ /mancha/
ಬೆಕ್ಕು /bekku/
ತುಟಿ /tuti/

Test items:-

List-A

ಲೋಟ /lo:ta/
ಏಣಿ /e:ṇi/
ಚಾಕು /cha:ku/
ಬಸ್ಸು /bassu/
ಗೂಬೆ /gu:be/
ಕತ್ತು /kat̪t̪u/
ಲಾರಿ /la:ri/
ಮನೆ /mane/
ನಳ್ಳಿ /nalli/
ಮೇಕೆ /me:ke/
ಮೊಲ /mola/
ಕಾಗೆ /ka:ge/
ಸೇಬು /se:bu/
ಬೀಗ /bi:ga/
ಕೋಳಿ /ko:ḷi/
ಹೂವು /hu:vu/
ಮೂಗು /mu:gu/
ಹಸು /hasu/
ಮಳೆ /maḷe/
ಕಪ್ಪೆ /kappe/
ಕಣ್ಣು /kaṇṇu/

List-B

ಕಣ್ಣು /kaṇṇu/
ಹೂವು /hu:vu/
ಕಾಗೆ /ka:ge/
ಕಪ್ಪೆ /kappe/
ಮೊಲ /mola/
ಏಣಿ /e:ni/
ಮಳೆ /maḷe/
ಲೋಟ /lo:ta/
ದಾರ /d̪a:ra/
ಚಾಕು /cha:ku/
ಮನೆ /mane/
ನಳ್ಳಿ /naḷḷi/
ಓಲೆ /o:le/
ಬಸ್ಸು /bassu/
ಕತ್ತು /kat̪t̪u/
ಗೂಬೆ /gu:be/
ಛತ್ರಿ /chat̪ri/
ಮೇಕೆ /me:ke/
ಸೇಬು /se:bu/
ಬೀಗ /bi:ga/
ಲಾರಿ /la:ri/

ದಾರ /d̪a:ra/
ಛತ್ರಿ /chatri/
ಚೀಲ /chi:la/
ಮೀನು /mi:nu/
ಮೇಜು /me:ju/
ಇಲಿ /ili/
ಸೂಜಿ /su:ji/
ತಲೆ /t̪ale/
ಕಿವಿ /kivi/
ಪೆನ್ನು /pennu/
ಮರ /mara/
ಬಳೆ /baḷe/
ಕಾಲು /ka:lu/
ಗಂಟೆ /gante/
ಸರ /sara/
ಚೆಂಡು /chendu/
ರೈಲು /railu/
ಕಾರು /ka:ru/
ಒಲೆ /o:le/
ಆನೆ /a:ne/
ತಟ್ಟೆ /t̪atte/
ಗಿಣಿ /gini/
ಹಾವು /ha:vu/
ನಾಯಿ /na:yi/
ಹಲ್ಲು /hallu/
ಕಾಸು /ka:su/
ಸೂರ್ಯ/su:rya/
ನೀರು /ni:ru/
ಎಲೆ /ele/

ಮೂಗು /male/
ಕಾಗೆ /ka:ge/
ಗಿಣಿ /gini/
ತಟ್ಟೆ /t̪atte/
ಸರ /sara/
ಕಾರು /ka:ru/
ಪೆನ್ನು /pennu/
ನೀರು /ni:ru/
ಬಳೆ /bale/
ಆನೆ /a:ne/
ಚೆಂಡು /chendu/
ಹಲ್ಲು /hallu/
ಮರ /mara/
ಮೀನು /mi:nu/
ನಾಯಿ /na:yi/
ಕೋಳಿ /ko:ḷi/
ಕಿವಿ /kivi/
ಇಲಿ /ili/
ಸೂರ್ಯ/su:rya/
ಕಾಸು /ka:su/
ಕಾಲು /ka:lu/
ಎಲೆ /ele/
ಚೀಲ /chi:la/
ಮೇಜು /me:ju/
ಸೂಜಿ /su:ji/
ಗಂಟೆ /gante/
ರೈಲು /railu/
ತಲೆ /t̪ale/
ಹಾವು /ha:vu/

NOTE: (Lists 'A' and 'B' are reverse orders of lists A & B)