PERCEPTION OF TIME COMPRESSED SPEECH IN BILINGUALS

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Reg. No. M. 9017

Dissertation submitted as part fulfilment for the second year

M.Sc. (Speech and Hearing) to the University of Mysore

All India Institute of Speech and Hearing

1992

........To that Transcendental

and Eternal light of my life

CERTIFICATE

This is to certify that the Dissertation entitled: **"PERCEPTION OF TIME COMPRESSED SPEECH IN BILINGUALS"** *is a bonafide work, done in part fulfilment for the Second year M.Sc. (Speech and Hearing) of the student with* **Reg.No.M9017.**

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1992

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CERTIFICATE

This is to certify that the Dissertation entitied: **"PERCEPTION OF TIME COMPRESSED SPEECH IN BILINGUALS"** *has been prepared under my supervision and guidance.*

MYSORE
1992

Dr.PRATHIBHA KARANTH
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DECLARATION

This dissertation entitled **"PERCEPTION OF TIME COMPRESSED SPEECH IN BILINGUALS"** *is the result of my own study under the guidance of* **Dr.PRATHIBHA KARANTH,** *Professor and Head of Department of Language Pathology, All India Institute of Speech and Hearing, Mysore and has not heen submitted earlier at any other University for any other Diploma or Degree.*

MYSORE **Reg.No. M.9017**
1992

ACKNOLWEDGEMENT

At the outset I'd like to express my heartfelt gratitude to my guide Dr.KARANTH for having been able to fit me into her busy schedule. Thank you maam for having guided me to a language of semantic congruity, integrity and logicity.

I'd like to express my sincere thanks to Dr(Miss)S.NIKAM, Director, All India Institute of Speech and Hearing for having permitted me to carry out this study.

Thank you subjects for so patiently volunteering.

My hearty acknolwedgement to the Staff of Department of Speech Pathology especially Mrs.VIJAYSHREE & Mrs.SUCHITRA who catered to me with patience; Mr.KRISHNAMURTHY Research Assistant, Department of Speech Sciences who helped me with the statistical analysis and Mrs.BASANTHI DEVI, Lecturer in Linguistics, Department of Speech Pathology who made the linguistic analysis an easy task.

When the going was rough and tough, JAYA and SHAILA sifted me out with their understanding and patience, that tended towards infinity.

Thanks to MANJU and all my other Classmates and friends who helped me through.

A special thanks to Mr.ANTONY THOMAS Lecturer, Department of Clinical Psychology for teaching me that each day is a new beginning. Just keep going and learn to enjoy and cherish little moments that come by.

I owe it all to you, my Parents and Chechi for where I stand today, for whatever I am today.

Lastly I'd like to thanks Mr. Ravi for deciphering my scrawl as so quick a pace.

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INTRODUCTION

Mans most fascinating mystery has been, to understand himself. The ongoing researches to elucidate the underlying basis of the brain and language, has been a major step in this direction.

A large variety of questions dealt with, in current research, on the insight into human language processing relate to the rich potential in bilinguals. The picture we get of bilingualism, is one of a rich and dynamically developing field.

Parallely and expectedly, the ends of specialization is increasing the isolation between those who work in different sub-disciplines. Cross references between different fields is relatively rare. These kinds of cross-fertilisations would lead the whole of our researches to newer perspectives. This is the current need of the hour. Bilingualism and perception are two areas rarely looked upon as being related. Apparently the major work on bilinguals is mainly in production with little focus on perception.

Redundancy in a language is one such factor that would play an important role in speech perception. Obviously, there have been many ways to reduce redundancy including filtered speech, dichotic listening and temporal distortion of speech. Because of the complexity and neural redundancy of the central nervous system, stimuli of a complex nature are needed to study this.

One such procedure is to "compress" the speech signal temporally thereby reducing the communication time. The compression reduces the extrinsic temporal redundancy of the normal speech signal thus increasing the difficulty of the processing task by the internally redundant nervous system These implications have been based upon the "Subtlety" and the "Bottleneck" principles espoused by Jerger (1960).

The early development of an electro mechanical time compression expansion apparatus (by Fairbanks, Everitt 1954) and more recently the electronic time compression by computer has triggered a spate of investigations using time compressed word lists and sentences.

Data on the intelligibility of time compressed speech have been reported for groups of normal children and adults (Maki 1974; Manning et al 1975; Orchik et al 1976; Beasley et al 1976) groups of children having speech and hearing disorders (Sticht and Gray 1969; Maki et al 1976), aphasias (Rudnick and Barry 1974), articulatory defectives (Orchik and Oelschlager 1974), and reading impaired children (Freeman and Beasley, 1976). Groups of aged persons and persons with known on suspected central auditory problems have been studied (Luterman et al 1966; Konkle and Bess 1974; Barry and Kanter 1975; Korabic, Freeman and Church 1976). Many investigations have been carried out involving different tasks of comprehension (Fairbanks et al 1957; Wood 1975; Freeman and Church 1977) on time compressed speech material. Investigations done to elucidate the role of linguistic factors in the perception of time compressed speech stimuli has been very few.

A study by Beasley et al (1976) on the performance of native and non-native speakers of English on time compressed American English, shows native speakers to perform better than non native Indo-Dravidian and Spanish-English speakers. It is not known whether foreign accent has a significant effect on the performance, further it could be that the time compression may have interacted with the influence of foreign accent.

Further, the intelligibility of time compressed speech has also been reported to be influenced by listeners previous experience, word familiarity and native language (Foulke and Sticht 1969; Henry 1966). No studies on time compression of speech has been carried out in languages other than English.

Other factors such as literacy, language structure and language redundancy are hypothesised to influences perception. These factors could perhaps be determined more lucidly in multilinguals.

India is a country, with 1652 languages spoken as mother tongue (Mathew 1986). As such, it offers a unique avenue to such researches. Inspite of the potential resources prevailing in India, such studies are very few.

Thus the need for investigating further., the linguistic involvement in the discrimination of time compressed speech tests is warranted.

The present investigation was undertaken to study the performance of young native and non-native listeners of Hindi, well proficient in English, on a time compressed speech measure. The stimuli consisted of both Hindi and English sentences. The study was designed to investigate how different compression rates, linguistic aspects, such as language structure and language proficiency in native and non-native listeners of Hindi play a role on the speech compression tasks, in both Hindi and English.

In the following chapter, a browsing on the review of literature on time compressed speech in given, followed by, the chapter where the actual study is described.

It is never wrong to know, it is only wrong to assume that you have all the answers."

- Mildred Schuell.

REVIEW OF LITERATURE

This chapter aims at reviewing the literature on

2.1 Procedures for temporally distorting speech.

2.2 Processing of time compressed speech.

2.3 Intelligibility of time compressed speech in normal adults and children.

2.4 Clinical Implications of time compressed speech.

2.5 Factors affecting time compressed speech.

Redundancy is said to play a major role in the perception of sentential tasks. With time, numerous techniques have been introduced to decrease redundancy in speech.

Several investigations have employed temporally distorted speech signals, thereby reducing the temporal and spectral redundancy (Calearo and Lazzaroni, 1957) and consequently taxing the central auditory system. One such procedure is to compress the signal temporally, thus reducing the communication time. So, it also becomes a method of studying timing aspects in speech. Timing aspects of speech are being singled out in studies on voiced onset time (VOT), voice initiation time (VIT), speech initiation time (SIT) etc. The studies by Luterman et al (1966) and Sticht and Gray (1969) provided necessary impetus to investigators to pursue studies of the temporal nature of the auditory system for clinical purposes.

Time compressed speech, is defined as a procedure of Increasing rate of speech by systematically eliminating segments of the speech signal and combining the remaining portions, thereby obtaining compression without frequency alteration (Fairbanks et al 1954).

Research and applications of time varied speech signals has emerged largely in the past twenty five years, with investigations of direct pertinence to speech -language pathology and audiology occurring primarily within the past decade.

2.1 PROCEDURES FOR TEMPORALLY DISTORTING SPEECH

Beasley and Maki (1976) have described in detail several methods of time varying speech stimuli, including alteration in speaking rate and recorded play back speed as well as mannual, electromechanical and computerized sampling procedures. Speaking rate variation simply entails speaking at a different rate.

While this is a convenient method, it is limited to the range of human speaking rates available and also in the reliability of resulting speech signals i.e., most individuals can only increase their rates by about 30 percent and have difficulty controlling the overall duration of the signal, vocal inflection, consonant vowel and pause durations and co-articulatory interactions. Playback rate variation entails playing a recorded message at a rate different from the rate at which it was originally recorded. This method is also simple and convenient, but introduces artifacts into the resultant signal in the form of frequency shifts which are proportional to the resultant time shift.

Sampling procedures entail modifications of a recorded signal by discarding and retaining portions of the signal, thereby minimising the distorting effects of frequency alterations.

Mannual sampling requires removal of portions of recorded material and then splicing together the remaining portions of the recorded signal. This method allows for retaining and adding of silent intervals of selected duration, but the procedure is time consuming and tedious.

Electromechanical sampling entails the use of an electromechanical time compressor or expander, first developed by Fairbanks, Everitt and Jaeger (1954). This device allows for recording of a signal and then, through the use of a tape loop, temporally compressing the signal by deleting portions of it during the playback process, and simultaneously abutting the remaining portions. Temporal expansion of a signal can be accomplished by insertion of repeated samples during the playback process. This method is convenient but does not allow selection of specific parts to be discarded or retained, and the required technology is bulky and expensive.

Electronic Sampling entails the use of an electronic time compressor or expander by use of a minicomputer.

However arguments persist that time compressed speech should be referred to a time - altered or distorted speech and not time compressed speech. It is the result of segments, containing important cues to perception such as formant transitions etc being dropped out from a sample at random. However comparison of clinical populations or any 2 populations may be made based on this kind of speech (Gopal, 1990).

2.2 PROCESSING OF TIME COMPRESSED SPEECH

Some authors (Nichols and Stevens 1957) believe that the brain is capable of processing information faster than received from normal speaking rates and that compressed speech presents information at rates nearer to listener's processing capability. It appears then, that listening to compressed speech demands more efficiency from, or an improvement of those processes which mediate normal rate of speech in order to cope with a more difficult task of comprehending compressed speech. These processes were noted by Orret et al (1965), Woodcock and Clark (1968) to include a listener's ability to focus on phrases and sentences, rather than individual words, avoid excess attention to detail rapid shift of attention to input and exercise greater degree of attention and aural concentration.

Comprehension of compressed speech appears to depend on selective attention in listening for relational cues which would identify "meaning" units within sentences or paragraphs (Freedman and Johnson 1969). Understanding of a sentence for example requires that the listener accurately perceive the relative importance of elements in the sentence. Thus it was hypothesised that the process of listening to time compressed speech required. (1) a high degree of attention and concentration to most of the information and (2) focus of attention to the essential information presented in sentences and paragraphs. Efficient performance with regard to these process' would allow quicker synthesis of information, enhancing comprehension.

2.3 INTELLIGIBILITY OF TIME COMPRESSED SPEECH IN NORMALS

Investigations of the intelligibility of time varied speech have included the use of various stimulus materials as words, phrases and sentences, variations in signal characteristics as interstimulus intervals in a variety of populations. For normal hearing listeners, speech which has been time-varied using playback rate variation technique has been found to be significantly less intelligible than sampling procedures (Garvey 1953; Klumpp and Webster 1961; McLain 1962; Fletcher 1965; Foulke 1966; Daniloff, Shriner and Zemlin 1968). With both methods, intelligibility decreases with decreasing signal duration, with dramatic reductions in intelligibility occurring at about 33% in duration (33% time compression) for the playback rate variation technique and at about 70% decrease in duration (70% time compression) for sampling method.

In recent years, there have been efforts to develop standardized procedures and normative data for time - altered speech signals in order to overcome earlier equivocal findings with persons presenting disorders of communication. Beasley, Schwimmer and Rintelman -(1972b) suggested that some of the earlier investigations of time-altered speech which demonstrated equivocal results may have suffered from experimental design problems and methodological difficulties, including small population sample sizes and inappropriately easy test stimuli as well as low percentages of time compression and inappropriately high level of presentation.

Subsequently in a series of 3 investigations, Beasley and his associates obtained normative data on the performance of young normal hearing adults who were presented time-compressed mono-syllabic stimuli. Beasley et al (1972b) obtained data on normal hearing subjects using monosyllablic word list North Western University Auditory Test-6 (NU-6) at 0, 30, 40, 50 60, 70% compression at sensation levels of 8, 16, 24 and 32dB respectively. The words in each list were time-compressed/expanded according to procedures described by Konkle et al (1977b). Results indicated that intelligibility decreased with increasing percentage of time compression, to 60%, followed by a dramatic breakdown in intelligibility at 70% time compression. These data were expanded to include a 40dB sensation level by Beasley, Freeman and Rintelman (1973a), who presented the same stimuli to another group of normal hearing young adults and obtained a slight but non-significant improvement in scores over those obtained by Beasley et al (1972b) at 32dB sensation level. In a related investigation, Riensche, Konkle and Beasley (1976) using 80 normal hearing young adults, found that the results of time-compressed versions of Form A of NU-6 replicated the trends in the earlier study of Beasley et al (1972b).

Several investigators have studied the effect of grammaticalness, stimulus length, and presentation rate on the perception of sentential stimuli, thereby providing impetus into the diagnostic utility of such stimuli. Berver (1969) presented 50% time compressed and time-expanded, seven and nine word sentences using four levels of grammaticality to adult listeners. Results indicated that performance was better on time expanded stimuli and the grammatically complex sentence had apparently little effect on performance.

Beasley, Bratt and Rintelman (1980) suggested that sentential stimuli could be effective in assessing linguistic integrity of the central auditory system and because of the steep articulation function for these stimuli, they would be less likely to be subject to misperceptions associated with peripheral hearing problems. They studied the responses of 96 normal hearing young adults to presentations of the Central Institute for the Deaf (CID) (Silverman and Hirsch 1955) and Revised CID (RCID) (Harris, Haines, Kelsey and Clark 1961) sentence lists as well as a list of 7 word, third order sentential approximations under conditions of 0, 40, 60 and 70% time compression. The sentential approximations were constructed according to procedures described by Speaks and Jerger (1965), Beasley and Shriner (1973) and the various stimuli were presented at the sensation levels of 24 and 40 dB.

Intelligibility significantly decreased with decreased sensation level and increased compression time for each set of stimuli. Further, there was a significant decrease at 24dB sensation level in both 60 and 70% compression conditions, whereas the significant decrease in intelligibility at 40dB sensation level was observed only at 70 percent compression time were significantly more difficult than CID and RCID. For the CID and RCID sentences, a precipitous decrease in intelligibility occurred predominantly at 70% time compression. Beasley et al (1980) noted that the slopes of

CID and RCID stimuli were similar to those of time-compressed NU-6 stimuli, but somewhat higher than sentential approximation scores.

Further the higher sensation level appeared to be less beneficial for the sentencial approximations than the normal sentences, underscoring the distinct advantages for intelligibility with normal linguistic stimuli. Reinsche and Slate (1981) presented the Beasley et al (1980) sentences at 0, 40, 60% compression rates to teenagers (12.5 to 17.5 years) at 45 and 60dBSPL and obtained results similar to those in adults.

A few studies on time compressed speech have been done in children. These studies have shown time compressed words and sentences to be useful in identifying central auditory dysfunction in the reading impaired and in children having severe articulatory problems. Further, preliminary research suggests that subtle ear differences as a function of cerebral dominance occasionally may exist, though confirmation of such an effect has been elusive (Van Ort, Beasley and Riensche 1979, Riensche and Beasley 1979, Patterson and Reinsche, 1979).

Performance on time compressed speech has also been reported to be influenced by chronological age. Norms on time compressed speech tasks may vary considerably for children owing to greater variability of results.

Thompson (1973) presented forty sentences, divided into two grammatically based difficulty levels, to children varying in age from 5-6 to 9-6 years. The sentences were electro-mechanically time compressed. She found that recall accuracy (termed comprehension) improved as a function of age, decreasing sentence complexity and increasing time compression. Her data suggest that while the slower rates assisted the perceptual processing of the signal by the younger children, the older children tended to performs better under more rapid rates than under the slower condition.

King and Weston (1974) studied the ability of children to recall electro-mechanically time compressed speech. They found that younger children had, significantly more difficulty recalling sentences time-compressed by 50% of the original time than older children particularly on the longer sentences. They suggested that younger children, unlike older children, have not fully developed all the necessary strategies used in the perceptual processing of language, and consequently they need the normal word durations and inter-stimulus intervals for accurate perceptual processing.

Maki (1974) was the first one to study the discrimination performance of young children systematically on two measures of time compressed speech. The word intelligibility by picture identification (WIPI) test and the Phonetically balanced Kindergarten (PBK-50) lists were administered to sixty normal hearing children. Percentage correct scores improved as age and sensation level of presentation was increased and scores decreased with increasing time compression. Scores on the WIPI were consistent by higher sensation level and showed a smaller range than the PBK-50.

In a parallel study by Beasley, Maki and Orchik (1976) obtaining intelligibility scores on time compressed versions of WIPI and PBK-50, similar results were obtained. The use of WIPI is therefore recommended to be used with younger children whereas PBK-50 could be used with older children. The closed message set format of the WIPI, unlike PBK-50 which is an open set message format, has been described as more applicable to young children who exhibit speech and language problems.

Children's performance has also been studied in time compressed version of half list speech discrimination measures (Manning, Shaw, Maki and Beasley 1975). The necessity of shortened speech discrimination measures with reduced testing time is greater for children than for adults as children's task attentiveness during testing tends to decrease more rapidly than adults. In the study of Manning et al (1975) it was indicated that half-lists of PBK-50 can be used effectively in the clinical testing with time compressed tests.

Along the same lines, Orchik, Estrade, Danko and Holgate (1976) also attempted to standardize time compressed version of WIPI on a group of Kindergarten age children.

The above studies provide normative data for the use of time compressed speech as a measure of auditory perceptual processing. It has been stressed that prior to being employed clinically, the temporally altered measures must be studied adequately and evaluated with "normal" groups of population. Thus, attempts have been made by many authors to obtain norms for monosyllabic and sentential time compressed speech stimuli in adults and children.

2.4 TIME COMPRESSED SPEECH IN THE CLINICAL POPULATION

Earlier studies of clinical populations had restricted themselves to the use of mainly monosyllables with persons who have had brain tumors and old persons,, (Bocca and Celearo 1963; de Quiros 1964) and only recently few studies have dealt with populations presenting clinically significant pathologies.

Time compressed speech stimuli have been assumed to have the potential for assessment of lesions in the auditory cortex, based upon the results of clinical studies which used distorted signals with patients presenting such lesions, (Bordley and Haskin, 1955; Calearo, Teatini and Pestalozza 1962; Katz 1962; Jerger, 1964; Speaks and Jerger 1965.) Subsequent researches suggest that the auditory perceptual system was temporally biased (Hirsh, 1967 Aaronson, 1967; Beasley and Shriner, 1973) lent support to these earlier contentions. Calearo and Lazzaroni (1957) discussed the rationale for use of time-compressed speech stimuli for clinical purposes in terms of role played by external and internal redundancy in speech perception. External redundancy refers to the redundancy inherent in the speech signal. That is, the acoustic and linguistic characteristics of speech, together with the interactions between these respective components, provide significantly more information than necessary to permit normal processing of speech signals to take place. Internal redundancy, on the other hand, refers to the neurophysiological redundancy of the central auditory system per se, as evidenced by the many contralateral and ipsilateral neural pathways and interconnections known to be present in the central nervous system. The inherent redundancy within the human nervous system permits normal performance on traditional speech discrimination tests, even if a portion of the nervous system is damaged. If the external redundancy is reduced, for example through the process of time compression, the internal redundancy of the normal auditory system could be expected to compensate for the reduced temporal nature of this signal, resulting in normal intelligibility. This process may be called as speech normalisation. Sensitivity to relative timing of temporal pattern is suggested by experiments on speech perception.

Apparently listeners can normalise incoming speech signal for unique tune-related properties of the speaker, this process enables listeners to modify interpretation of important phonetic cues such as VOT (Miller and Libermen, 1979; Miller and Dexter, 1988; Miller and Grosjean 1981).

If the central auditory system suffers neural pathology, however then, compensation for signal distortion would be reduced. Time compressed monosyllables have been found useful for evaluating temporal lobe lesions and auditory perceptual disorders associated with articulation, reading and other language problems (Beasley and Maki 1976; Beasley and Freeman 1977; Lass et al 1984; Reinsche et al 1984). Time compressed sentences have differentiated both normal reading from reading impaired children (Freeman and Beasley, 1978) and children having history of severe misarticulation from those with no history of articulation problems (Riensche and Clauser 1982).

Although early investigators of the use of time-varied speech with clinical populations obtained unequivocal findings (Calearo and Lazaroni, 1957; Bocca and Calearo, 1963; de Quios, 1964; Luterman, Welsh and Melrose, 1966; Sticht and Gray 1969), they nevertheless stimulated interest in the clinical use of such stimuli. Recently, a number of investigators have employed the time-compressed versions of NU-6 and other stimuli to investigate auditory perceptual abilities of adult clinical populations. Their findings suggest that these stimuli may be effective in detecting diffuse lesions of temporal lobe, but that the information they provide should be interpreted with findings obtained from other measures (Echols - Chamber 1981). They should be employed as a part of a battery of tests (Beasley and Freeman, 1977; Willeford, 1976).

Kurdzeil, Noffsinger and Olsen (1976) presented the time compressed NU-6 stimuli to 16 subjects having surgically induced discrete right or left temporal lobe lesions and 15 subjects having diffuse unilateral cortical lesions involving at least the temporal lobe. The performance of the subjects having discrete anterior temporal lobe lesions showed little difference between ears on percentages of time compression. However the performance of the subjects having diffuse temporal lobe lesions was characterized by poorer performance in ear contralateral to lesion compared to ear ipsilateral to the lesion. Also a greater difference between the scores at 0 and 60% time compression was observed for ear contralateral to lesion than for ipsilateral ear.

Learning disabled children do not perform as well as normals in time compressed speech task (Mc Croskey and Thompson 1973; Mc Nutt and Chia-Len Li 1980, Simmons 1982). Auditory processing abilities of learning disabled were reminiscent of an earlier level of operation.

Aphasics performed poorer than normals because of auditory processing difficulties on WIPI (Word Identification of Picture Index) words. So this may be used for speech discrimination tasks in these subjects (Daniel J Orchik et al, 1977).

In an investigation employing eight aphasic subjects and a matched control group, Orchik, Walker and Larson (1977) found that the aphasic subject group performed poorer than control group at all levels on the WIPI. Ross and Lerman (1970) presented under 0, 30, 60% time compression conditions, the greatest difference in performance was at 60% time compression. Further, the aphasic subjects demonstrated comparable performance to that of control subjects at 0 and 30% time compression. Clinical investigators have attempted to facilitate comprehension of aphasic patients through the presentation of time-varied speech stimuli. The rationale for the use of such stimuli with this population is based on evidence that the aphasic deficit is at least partially temporal in nature (Efron, 1963; Ebbin and Edwards, 1967; Carpenter and Ruther Ford, 1973; Cermak and Moreines, 1976; Tallal and Newcombe, 1978). Using slowed speech, Albert and Bear (1974) and Gardner, Albert and Weintraub (1975) reported improvement in the comprehension performance of aphasic subjects, although other investigators have obtained conflicting results.

Brookshire (1973) suggested that some individuals may be unable to receive and process informations at the same time and would benefit from the insertion of pauses in between the speech signal. Liles and Brookshire (1975) using Token Test found improvement under a 5 second pause conditions compared to no pause condition. Weidner and Lasky (1976) found that the aphasic subjects demonstrated significantly improved performance on selected subtests of the Minnesota Test of Differential Diagnosis of Aphasic when stimuli were time expanded. Wohlert, Porch and Reinsche (1980) reasoned that aphasics may prefer to listen to a rate that facilitates their comprehensions. They examined subjects preferred listening rates relative to their comprehension of normal and time expanded revised Token Test commands, but failed to obtain definitive evidence of the aphasics preference ratings, relative to the facilitation of comprehension.

The findings reported in these numerous investigations of comprehension of temporally distorted speech by aphasic patients, though equivocal, cannot be ignored and indicate a need for a better understanding of the temporal nature of the aphasic deficit as well as the application of time varied stimuli to the diagnostic and therapeutic processes in these patients. For example, the clinician's presentation of test stimuli, lacking adequate temporal control may contribute to the variability in diagnostic tests results as well as to some of the inconsistent performance observed during aphasic therapy.

The performance of subjects presenting peripheral hearing loss also has been reported for time-compressed stimuli. Kurdzeil, Rintelman and Beasley (1975) saw the performance of nine subjects having noise induced sensorineural hearing loss. Articulation function of the group were similar to those obtained for normal hearing subjects, but mean scores were lower than normal at each time-compression condition. The difference between scores at 0 and 40% time compression for peripheral hearing loss subjects can be expected to range from 10-15% or higher, compared to less than 3% for normal hearing subjects.

Another investigation employing time compressed stimuli was designed to examine peripheral and central auditory function among patients having sickle cell anaemia. Sharp and Orchik (1978) noted that diffuse effects of sickle cell origis might be expected to produce peripheral and central auditory dysfunction. They presented time compressed NU-6 and WIPI stimuli to nine subjects having sickle cell anaemia and to a matched control group. Measures of peripheral hearing abilities scores on time compressed stimuli were on the overage 5 to 15% poorer in both ears for subjects with sickle cell anaemia compared to control group, thereby indicating reduced central auditory dysfunction.

Time-compressed sentences have been employed in the assessment of the auditory perceptual abilities of adults. Doran and Reiensche (1981) presented the 0, 40, and 60% time compressed CID, RCID and sentential approximations used by Beasley et al (1980) to a group of stuttering and non-stuttering adult subjects at sensation levels of 24 and 32dB. The performance levels of the two groups were similar though there was a subtle difference in pattern of performance over various time compression levels.

Time compressed speech stimuli have been employed audiologically with aging subjects (Calearo and Lazzaroni, 1957; de Quiros, 1964; Sticht and Gray, 1969; Di Carlo and Taub, 1972; Konkle et al 1976) as well as subjects having central auditory dysfunction (Calearo and Lazzaroni, 1957; de Quiros, 1964; Kurdzeil, 1973) and sensory neural impairment (Schon, 1970; Kurdzeil et al 1975).

Investigators have examined the potential of time expanded speech as a means to improve listeners perceptual judgements of speech production. Using an electromechanical technique, Lass and Foulke (1976) presented 0%, 150%, 200% expanded speech samples from misarticulating speakers and found that a significantly greater number of misarticulations were identified accurately. Manning, Lee and Lass (1978) presented 0%, 150% and 200% time expanded conditions of stutterers compared to normal recordings for identification of one, two, three unit part word repetitions.

No improvement occurred in the identification of 2 and 3 unit part word repetitions though significant improvement in identification of one unit repetition was present. Leeper et al (1980) examined the potential value of time expanded speech as aid in improving listeners* perceptual judgements of hypernasality in connected speech samples. Findings indicated that the listeners' confidence in their judgements decreased under time expanded conditions.

The potential utility of time compressed speech as efficient means to transmit information, as aid in educational program and tool to study basic nature of human information processing has been explored (Rieko et al 1975). Teaching using time compressed speech was found to improve abstract ability in children, a process noted to be similar to deriving essence from information (Daniel et al 1973).

2.5 FACTORS AFFECTING INTELLIGIBILITY ON TIME COMPRESSED SPEECH

Numerous factors have been found to affect performance on time compressed speech tasks De Quiros (1964) listed. Some of the sources of error in the time compressed speech test. They include:

1) Attention and memory span
2) Patient's sensory response
3) Effects of lesion
4) Patients social, educational and linguistic background

2.5.1 Memory:

Freeman and Church (1977) investigated the ability of a group of normal young adults to recall and repeat a set of time compressed five-word first-order sentential approximations. Four levels of time compression (0, 20, 40, and 60%) were presented at four sensational levels (16, 24, 32 and 40 dB). The results demonstrated that normal subjects are capable of recalling and repeating, without difficulty, four lists of the five word first-order sentential approximations at various levels of time compression. The authors purpose that if it is true that many central auditory processing impairments affect memory and that the auditory discrimination errors may be a by-product of^or co-exist with an auditory memory deficit, then a sentential test which could measure both of these parameters may have diagnostic and clinical utility.

2.5.2 Sensation level:

This is seen from all studies on time compressed speech Sensation level is a factor directly related to intelligibility of time compressed speech (Beasley et al 1972; Maki et al 1976; Manning et al 1977; Kurdzeil and Noffzinger 1973; Beasley et al 1980; Rudnick and Barry 1974).

2.5.3. Age:

Norms on time compressed tasks may vary considerably in children owing to the greater variability of results. Performance on time compressed speech has also been reported to be influenced by chronological age.

King and Weston (1974) suggested that younger children unlike older children, have not fully developed all the necessary strategies used in perceptual processing of language and consequently they need normal word durations and interstimulus interval for accurate perceptual processing.

2.5.4 Stimulus and Talker variation:

Further, the effect of word list and talker variation on time-compressed speech discrimination scores were high-lighted by De Chicchis, Orckik and Tecca (1981). CID W-22 (Hirsh et al 1952) and NU-6 word lists were studied using commercially available recordings. Also the performance on the Auditec NU-6 recordings were compared to the data from the original recordings by Beasley et al (1972b), who used a different talker for NU-6. Results indicated that different word lists with ostensibly similar difficulty levels under normal conditions, may give dissimilar results when altered in some ways, as in temporal distortions. Also, the effect of non-native talker variation was even more dramatic, in that gores for the Auditec recordings of NU-6 were markedly poorer at all levels of time compression than those obtained in Beasley's recordings.

2.5.5 Linguistic Background:

The intelligibility of time compressed speech has also been reported to be influenced by listeners' previous experience,word familiarity and native language (Foulke and Sticht 1969; Heiry 1966 cited by Foulke and Sticht, 1969).

To this effect, Nikam, Beasley and Rintelmann (1976) studied the performance of 70 Non-native speakers of English on time-compressed versions of four lists of Form B of NU-6 (same as those used by Beasley et al 1972). The results obtained were compared to the performance of normal hearing native English speakers of Beasley et al (1972) study. Indo-Dravidian and Spanish-English speaking subjects were given experimental stimuli at six time compression (0% and 30% through 70% in 10% steps) levels at sensation levels of 8, 16, 24, 32 and 40dB SL.

In support of earlier studies, it was found that intelligibility decreased as the percentage of time compression increased and sensation level decreased. The adverse effects of time-compression could be offset upto 60% by increasing the presentation level.

A comparison of results to the study by Beasley et al, indicated that native speakers of English performed better than did both speakers of Indo-Dravidian and Spanish groups under nearly all conditions of time compression and sensation levels. One of the facts that this study emphasizes is that the linguistic background has definite effect upon the performance of listeners on time compression tasks.

No studies have been carried out on time altered speech tests in language other than English. It would be interesting for such studies to be carried out. It was found that the entropy per speech sound in bits English is 4.03 as against 4.37 in Hindi (Ramakirhsna et al, 1960). This implies that English is a more redundant language than Hindi. English is a much more efficient language then Hindi because it requires less number of information in bits, to convey the same information (Ramakrishna et al 1960). This structure of a language in terms of its redundancy would be factor related to performance on time compressed speech tasks.

The question that follows is does intelligibility on time compressed speech differ across languages. Further, the exact role, the level of proficiency in a language, and the structure of the language itself in the perception of time compressed speech are factors yet to be unraveled. The present investigation attempts to study these factors.

METHODOLOGY

The main objectives of the present study were to assess the following:

1) Does the intelligibility of time compressed speech decrease with increased rates of compression.
2) Does the structure of the language influence the perception of time compressed speech in English Vs.Hindi,
3) Does the proficiency in the language influence perceptual abilities on time compressed speech.

3.1 SUBJECTS

Thirty normal hearing adults (10 males, 20 females) ranging in age from 17 years 4 months to 23 years 7 months with a mean age of 19 years (from a student population) served as subjects for this study. Each subject was required to

a) have otologically normal ears
b) have proficiency in at least two languages - Hindi and English. Most subjects were multilunguals knowing three to five languages namely Hindi, English, Tamil, Marathi, Malayalam and Bengali.
c) have the ability to speak, comprehend, read and write English.

Of the thirty subjects, fifteen were native speakers of Hindi and 15 were non native (poor) speakers of Hindi.

The non native speakers of Hindi:

a) did not have Hindi as their mother tongue.

b) had been exposed to the language only after 8 years of age.

c) had learnt the language formally

d) could comprehend Hindi (Nine of them could comprehend and read Hindi but writing and speaking was reportedly poor. Six of them could only comprehend the language).

The native speakers of Hindi satisfied the following criterias:

a) They were native speakers of Hindi

b) All of them had initially learnt Hindi informally at home and later formally in school.

c) All of them could speak, comprehend read and write Hindi with a reportedly high level of proficiency.

3.2 EXPERIMENTAL STIMULI

The stimuli used in this study were fifteen Hindi and fifteen English sentences. The sentences chosen, were of equal complexity in both the languages and an attempt was made to match the total number of syllables in these sentences, as far as possible.

The sentences were tape recorded at normal conversational level by a non native English and non native Hindi speaker who spoke Indian English and South Indian Hindiand compressed to 40, 50, 60% in time.

3.3 EQUIPMENT

Revox Stereo Tape recorder (B77) with headphones-Revox 3100.

3.4 INSTRUCTION TO THE SUBJECTS

A standard set of instructions was given to each subject as follows "you will be hearing a series of meaningful sentences. All you have to do is to write the sentence down on a response sheet in a manner convenient to you. If you do not hear a word well, try to guess it; and if you do not still succeed leave a blank space and go on to the next sentence.'

3.5 METHOD

The fifteen . good and poor speakers of Hindi were randomly assigned to three groups so that each group consisted of five good and five poor speakers of Hindi, the order of presentation was randomized in order to eliminate the practice effect.

TABLE-3.1: Showing the Order of Presentation of the Hindi Sentences among the Three Groups:

Order of presentation	1	2	3
Group 1	H1 (1-5)	H2 (6-10)	H3 (11-15)
Group 2	H2 (1-5)	H3 (6-10)	H1 (11-15)
Group 3	H3 (1-5)	H1 (6-10)	H2 (11-15)

After one week the English sentences were presented as follows:

TABLE-3.2: Showing Order of Presentation of English Sentences among the Three Groups:

Order of presentation	1	2	3
Group 1	El (1-5)	E2 (6-10)	E3 (11-15)
Group 2	E2 (1-5)	E3 (6-10)	El (11-15)
Group 3	E3 (1-5)	El (6-10)	E2 (11-15)

Abbreviations used:

H1 = 40% speech compression in Hindi

H2 = 50% speech compression in Hindi

H3 = 60% speech compression in Hindi

El = 40% speech compression in English

E2 = 50% speech compression in English

E3 = 60% speech compression in English

The number in brackets represents the serial number of the sentences (given under Appendix) presented.

Appropriate statistical analysis were applied to arrive at meaningful results and the results have been discussed in the next chapter.

RESULTS AND DISCUSSION

The present study was conducted on 30 young adults, who were presented with fifteen sentential stimuli in both Hindi and English at 40, 50, 60 percent rates of compression. Results of the current study are presented in this chapter. These findings are discussed in light of previous studies of a similar nature and their implications have been drawn.

4.1 EFFECT OF TIME COMPRESSION IN HINDI AND ENGLISH

The total number of correct responses obtained by the thirty subjects in Hindi and English at each rate (40, 50, 60 percent) of compression was calculated. These scores were converted to mean percent scores and standard deviation at each rate of time compression was derived (Table-4.1, 4.2). Sentence number fifteen in Hindi was eliminated because most of the subjects had performed poorly on it. This was attributed to the fact that the sentence contained thirty syllables which could be beyond the auditory memory of the subjects.

TABLE-4.1: Showing the mean per cent, correct score and standard deviation (SD) at various time compression conditions in Hindi

Percentage of time compression	Mean Percent Score	SD Percent Scores
40	90.7	3.6
50	89.6	4.3
60	82.0	8.3

TABLE-4.2: Showing the mean per cent, correct 3core and standard deviation (SD) at various time compression conditions in English

Percentage of time compression	Mean Percent Score	SD Percent Scores
40	99.4	4.07
50	95.6	2.2
60	91.9	5.9

The mean percent correct scores was seen to drop as a function of time compression from 40 to 60 per cent, both in Hindi and English.

A 't' score analysis was done in order to find the significant difference, if any, between the mean percent correct scores obtained at different rates of time compression in Hindi and English (Table-4.3 and 4.4).

TABLE-4.3: Showing the significance (0.01 level of significance) between different rates of time compression in Hindi

Rate of Compression	Rate of Compression		
	40%	50%	60%
40%		–	+
50%			+
60%			

TABLE-4.4: Showing the significance (0.01 level of significance) between different rates of time compression in English

Rate of Compression	Rate of Compression		
	40%	50%	60%
40%		–	+
50%			–
60%			

The above analyses shows a significant difference (at 0.01 level) between F0 and 60 per cent, and 40 and 60 per cent compression rates in Hindi (Table-4.3) ie., the performance falls from 40 to 60 percent speech compression rate.

A significant difference was obtained between 40 and 60 percent compression rates in English too, but not between 40 and 50 percent, i.e., Intelligibility falls rapidly as the rate of time compression reaches about 50% in Hindi. This observation was not made in English.

Results of the present study show that the general trend of poorer performance with increasing rates of time compression in both Hindi and English, though a statistical significance was not obtained between performance at all rates of compression (40 and 50 percent, 50 and 60 percent in English and 40 and 50 percent in Hindi). Thus, the intelligibility scores fall in Hindi as they do in English, with increasing rates of time compression (40 to 50 to 60 percent).

Earlier studies, using both normals (Beasley et al 1972, Beasley et al 1976, 1980) and clinical group of subjects (Kurdzeil et al 1975; Manning et al 1977) have demonstrated that as the rate of time compression was increased the intelligibility scores decreased significantly. This effect was found with both consonant - neutral vowel - consonant (CNC) monosyllables as well as with sentential stimuli (Beasley et al 1980). Thus increasing rates of time compression does affect its intelligibility in both languages namely Hindi and English.

4.2 EFFECTS OF TERMS COMPRESSION IN DIFFERENT LANGUAGES-HINDI AND ENGLISH

Does the performance of subjects, with a high level of proficiency in both languages, follow a similar trend in both languages. This was analysed by comparing the performance of native (proficient) speakers of Hindi with their scores in English across 40, 50, 60 percent compression rates. The mean percent correct scores and standard deviation (SD) was obtained for the fifteen native speakers of Hindi, in Hindi and English at different compression rates (40, 50 and 60 percent) (Table-4.5).

TABLE-4.5: Showing mean percent correct scores and standard deviation (SD) in Hindi and English at various compression rates for native Hindi speakers

Percentage of Time compression	[Scores in Hindi		Scores in English	
	Mean %	SD %	Mean %	SD %
40	93.1	3.2	96.4	1.2
50	92.1	4.0	95.5	1.7
60	88.7	3.4	90.1	.1

The above table shows a decrease in performance in both Hindi and English at increased rates of compression. This effect is seen more in Hindi. The variability of scores is also seen to be high at increased rates of time compression in English. Native Hindi speakers perform better in English than in Hindi at similar rates of speech compression.

This could be due to the fact that Hindi is a less redundant language than English. Ramakrishna et al (1968) studied the entropy per speech sounds in different Indian languages (Table-4.6) and concluded that Hindi has greater entropy per speech sound in bits than English. This implies the decreased redundancy in Hindi than in English.

TABLE-4.6: Showing entropy per speech sound in bits in different Indian Languages

Language	English	Hindi	Marathi	Tamil	Mala-yalam	Telegu	Kan-1 nada
Entropy per speech sound in bits	4.03	4.37	4.37	4.31	4.6	4.5	4.6

Time compression is meant ' to reduce the external redundancy of a stimuli. This reduction may have greater influence on a less redundant language namely Hindi. Hence subjects equally proficient in Hindi and English, tend to perform poorer in Hindi than in English on a time compressed speech task. This could be a factor contributing to the results obtained in the present study.

Further Hindi is a language spoken at a rate faster than other Indian languages and Indian English (Bharadraj 1979). Hence increasing the rate further in Hindi, would considerably decrease its intelligibility further more than English.

In order to observe the significance of means (at 0.01 level) at different rates of compression in Hindi and English, a t-score analysis was carried out (Table-4.7).

TABLE-4.7: Showing the significance (0.01 level) difference of means between performance of native speakers of Hindi, on Hindi and English with time compression speech stimuli

Rate of Compression (English)	Rate of Compression (Hindi)		
	40%	50%	60%
40%	-		
50%		-	
60%			-

Table-4.7 however shows no significant difference between Hindi and English at 40, 50 and 60 percent compression rates by listeners proficient in both languages (native Hindi speakers and non-native English speakers).

No such studies have been carried out in languages other than English, thus it appears that redundancy in a language and the rate of speech in that language are contributing to perception on time compressed stimuli.

4.3 TIME COMPRESSION AND PROFICIENCY IN THE LANGUAGE

Proficiency in the language as a variable could be studied only in Hindi. All the subjects in this study were students highly proficient in English.

The mean percent carried scores and standard deviation (SD) was derived on time compressed Hindi sentences between the native (proficient) and non-native (non-proficient) speakers of Hindi (Table-4.8).

TABLE-4.8: showing mean percent correct scores and standard deviation (SD) between native and non-native speakers of Hindi on the Hindi time-compressed speech stimuli

	[Non-native speakers of Hindi	Native speakers of Hindi
Mean Percent	83.5	91.3
SD	7.2	2.6

The present study shows a significant difference (at 0.01 level) between the native and non native speakers of

Hindi on the time compressed Hindi stimuli. The results in the present study are in agreement with the study on time-compressed consonant-vowel-consonant monosyllable by native and non-native listeners of American English (Beasley et al 1976). Native speakers performed better than non-native on a speech compression task. Differences in the performances scores are observed at the different rates of compression in Hindi between native and non-native speakers of Hindi (Table-4.9).

TABLE-4.9: Showing mean percent scores and standard deviation (SD) obtained by native versus non-native speakers of Hindi and various rates of compression

Perc entage of time compression	Non-native speakers		Native speakers	
	Mean % score	Mean S.D.	Mean % score	Mean S.D.
40	88.6	2.2	93.1	3.2
50	83.6	3.1	92.1	4
60	75.32	5.5	88.7	3.4

Table-4.9 shows performance scores on the time compressed task in Hindi across different rates to be better in native speakers of Hindi then in non-native speakers of Hindi. An increased variability of scores is obtained at the 60 percent compression rate among non-native Hindi speakers.

Significant difference of means was obtained at different rates levels of time compression between native and non-native speakers of Hindi.

TABLE-4.10: Showing the significant difference of means (0.01 level) between native and non-native speakers of Hindi, with different rates of speech compressed stimuli in Hindi

Rate of compression (non-native speakers of Hindi)	Rate of compression (native Hindi speakers)		
	40	50	60
40	+		
50		+	
60			+

Table-4.10 indicates a significant difference in the performance on the Hindi time-compressed stimuli at all compression rates (40, 50 and 60 percent) between native and non native speakers of Hindi.

De Quiros (1964) stated that subjects social emotional and linguistic background are important factors to be considered in time-compression experiments. Among other factors, familiarity and experience with the dialect in which the message is spoken and message familiarity have been demonstrated to influence speech discrimination ability (Lane 1963).

Orret et al (1965), Woodcoch (1968) reported that listeners of time compressed speech should be able to focus on phrases and content words rather than all the words. Comprehension of compressed speech appears to depend on selective listening for relational words which would identify "meaning" units within a sentence or a paragraph (Freeman and Johnson 1969).

The understanding of time compressed sentences therefore requires the listener to accurately perceive the relative importance of elements in a sentence. The non-native speakers of a language may not be proficient enough, at this.

A subjective analysis of the performance of non-native listeners of Hindi, on the Hindi time compressed sentences revealed that the error words were marked words, not very familiar to a non-native speaker.

These factors contributing to the proficiency in a language could be important cues to the perception of time compressed speech. Thus results of the present study support the findings of Foulke and Sticht (1966) who reported that the intelligibility of time compressed speech is influenced by the listeners previous experience and word familiarity. These factors indirectly govern his proficiency to scan sentences to obtain important cues from it.

While this study demonstrates the influences of language, language structure and familiarity on time compression of speech stimuli, it stresses the fact that such factors should be considered before making conclusions on intelligibility of speech compressed material.

It is imperative that further investigations employ standard speech stimuli on normal and clinical (namely aphasic and other brain damaged) populations be carried out. The acquisition of such data would help us understand language organistion and processing better.

SUMMARY AND CONCLUSION

The present investigation reports on the performance of thirty young adults (native and non-native speakers of Hindi with a high level of proficiency in English) on the time compressed version of English and Hindi sentences. The study aimed at

- Analysing the influence of time compression (40, 50, and 60 percent compression rates) on sentential stimuli in English and Hindi.

- Establishing, if any, the differences between the perception of time compressed speech stimuli in English and Hindi by speakers proficient in both the languages.

- Evaluating the effects of levels of proficiency in a language on the perception of time compressed stimuli.

The results support earlier findings that the performance decreases with increased rates of time compression. Further, performances at 40 and 60 percent time compression rate in English and 40 and 60 percent and 50 and 60 percent time compression in Hindi were found to be significantly different (0.01 level of significance).

Equally proficient speakers of Hindi and English were found to perform poorer in Hindi than in English. This variation in this performance on the two languages was found at all the levels of time compression, this supports the hypothesis that the redundancy and rate of speech, play a role in the perception of time compressed speech stimuli. Hindi being a less redundant language with its increased rate of speech could be contributing to the decreased performance of these subjects in Hindi. Though differences were observed between the two languages they were not significant. Hence definite conclusions are unwarranted and require further investigations.

The study also demonstrates the efficiency on performance of time compressed speech as a function of proficiency in that language.

SUGGESTIONS FOR FURTHER RESEARCH

In view of the above findings, it would be of much importance to study the effect of time compressed speech in different languages as a measure to study the language itself, in multilingual groups with different language combinations. Of further interest would be to obtain these norms and to observe the differences between the clinical and a clinical populations.

Improved techniques of time compression would help us elucidate much information on the timing aspects of speech in different languages India being a country with different languages, the prevalent multllingualism should provide a rich ground for further research.

BIBLIOGRAPHY

Beasley, D.S. and Maki, J.E. (1976). Time and Frequency Altered Speech in N.J.Loss Contemporary Issues in Experimental Phonetics. New York: Academic Press.

Beasley, D.S. and Rintleman, A. (1976). Children's Perception of Temporally distorted sentential approximation of varying length. Audiology. 15: 315-325.

Beasley, D.S. and Freeman, B.A. (1977). Time Altered Speech as a Measure of Central Auditory Dysfunction in Keith,R.W. (Ed), Central Auditory Dysfunction. New York: Grune and Stratton.

Beasley, D.S., Freeman, B.S. and Rintleman, W.F. (1972). Perception of time compressed CMC monosyllables by normal listeners. Journal of Auditory Research. 12: 71-75.

Beasley, D.S., Maki, J.E. and Orchik, D.J. (1976). Children's Perception of Temporally distorted speech on two measures of speech discrimination. Journal of Speech and. Hearing Disorders. 41: 216-225.

Beasley, D.S., Bratt, G.W. and Rintleman, W.F. (1980). Intelligibility of Time-Compression sentential stimuli. Journal of Speech and Hearing Research. 23: 722-731.

Berry, M.K. and Canter, G.J. (1975). The effect of time altered speech on. the Auditory comprehension of_ Adult Aphasics. ASHA, 17, Paper Presented at American Speech and Hearing Association.

Bharadwaj, A.K. (1979). Personal communication. Combridge, Cambridge University Press.

Bratt (1976). The_ effects of time, compression on the. intelligibility of 3 sentential message tests. ASHA 18, Paper Presented at American Speech and Hearing Association, 671 (T-4).

Calearo, C. and Lazzaroni, A. (1957). Speech intelligibility in Relation to the speed of the message. Laryngoscope, 67: 410-419.

Dicarlo, L. and Taub, H. (1972). The influence of compression and expansion on the intelligibility of speech by young and aged Aphasics individuals. Journal of Communication Disorders. 5: 299-306.

Daniel, P.S. and Ernst, B.B. (1973). The effects of listening to compressed speech on some intellective process of children of lower socio-economic status. Journal at Auditory Research, 13: 238-246.

Datson, M.M. and Rastatter, M.P. (1985). Effects of time compressed speech on auditory processing abilities of learning disabled children. Journal at Auditory Research. 25: 167-173.

Freeman, B.A. and Beasley, D.S. (1978). Discrimination of time altered sentential approximation of monosyllables by children with reading problems. Journal at Speech and Hearing Research. 21: 497-506.

Foulke, E and Sticht, T.G. (1979). Review at Research on the intelligibility and. comprehension at Accelerated Speech. Psychological Bulletin, 72: 50-62.

Korabic, E.W., Freeman, B.A. and Church, G.T. (1976). Performance at normal hearing young adult and elderly subjects on time, expanded speech tests, ASHA 18, Paper Presented at American Speech and Hearing Association 671 (T-4).

Kurdzeil, S.A., Noffsinger, D. and Olsen, W. (1976). Performance by cortical lesion patients on 40 and 60% time compressed materials. Journal at American Audiology Society. 2: 3-7.

Kurdzeil, S.A., Rintleman, W.F. and Beasley, D.S. (1975). Performance of Noise-Induced Hearing Impaired listeners on time-compressed consonant-nucleus-consonent monosyllables. Journal at American Audiology Society. 1(2): 54-50.

Lane, H. (1963). Foreign accent and speech distoration. Journal at Acoustical Society at America. 35: 451-453.

Lutermann, D.M., Walsh, O.L. and Melrasi, J. (1966). Responses of aged males to time altered speech stimuli. Journal at Speech and Hearing Research. 9: 226-239.

Maki, J.E. (1974). Child perception of time, compressed speech using two measures at speech discrimination. ASHA, 16, Paper Presented at American Speech and Hearing Association 523 (T-4).

Maki, J.E., Beasley, D.S., Shaup, J.E. and Bess, F.H. (1976). Speech discrimination and response latency at normal -hearing and hearing impaired children as a function at time compression. ASHA, 18, Paper Presented at American Speech and Hearing Association 671 (T-4).

Manning, W.H., Johnston, K.L. and Beasley, D.S. (1977). The performance of children with auditory perceptual disorders on a time-compressed speech discrimination measure. Journal of. Speech and Hearing Disorders. 42: 77-84.

Orchik, D.J. and Oelschlaeger (1973). Time compressed speech discrimination in children and its relationship to articulation. Journal of American Audiology Society.

Ramakrishna.5. (1968). Efficiency of Indian Languages. A

of

Riensche, L., Konkle, D.F. and Beasley, D.S. (1976). Discrimination of time compressed monosyllables by normal listeners. Journal of. Auditory Research, 16: 98-101.

Riensche, L., Orchik, D.J. and Beasley, D.S. (1976). cited in Chris Code and Martin Ball (Ed). Experimental Clinical Phonetics -Investigatory Techniques in Speech Pathology and therapeutics. London and Canberre: Croom Heln Ltd: 145-165.

Riensche, L., Elate, N.L. and Lamb, L.E. (1985). Normal hearing teenagers performance on time compression speech stimuli. Journal of_ Auditory Research. 25(1): 1-4.

Rudnich, K. and Berry, R.C. (1974). Perception of rate altered sentential approximations by. Normal and. Aphasic children. ASHA. 16, Paper Presented at American Speech and Hearing Association 523 (Th-5).

Schriner, S., Beasley, D.S. and Zemlin, W.R. (1971). Effects Of time, compression on speech discrimination scores using CNC_ words (NU-6). ASHA. 13, Paper Presented at American Speech and Hearing Association 563 (SA-7).

Schwab, R. and Robert, M.W.T. (1975). Effects of speech compression on affection dimensions of dialogue. Journal of Auditory Research. 15, 172-176.

Sorkin, R.D. and De Moris A Montgomery (1990). Effect of time compression and expansion on discrimination of tonal patterns. Journal of Auditory Research. 90(2): 846-857.

Sticht, T.G. and Gray (1969). The intelligibility of time compressed words as function of Age and Hearing Loss. Journal of_ Speech and Hearing Research. 12: 443-448.

APPENDIX-IA

Sentences in Hindi used in time compression task.

1) woh ʌpnī pʌtnI ke sa:tʰ dentIst ke pa:s ja:ne ko bʌs pʌkʌḍa.

(He went with his wife by bus to visit the dentist)

2) mere dada dadIyō ka jʌnʌm mʌhayudʰ ke karib do sa:l pehɛle hua.

(My grand parents were born around two years before the war)

3) us vrIdʰ puruʃ ko In ʃrabō ka ka:fI anubʰʌv haI

(The old man has a lot of experiences with these liquors)

4) Is yuvraja ne apne du:sʌre mɛhɛl ka nIrma:ṇ ka nIrikʃʌṇ kIya

(This young king supervised the construction of his second palace)

5) purohIt gIta ke dʌs prʌʃn ko kʰuʃi se hʌr subʌh pʌdʰta hai

6) go:pal ne kʰane ke ba:d ek gla:s lassI pi lIya.

7) pulIs mɛn ne co:r ka baŋk ke cʰʌt pʌr picʰa kIya.

(The policemen chases the burglar on the roof of the bank)

8) Is ka:r ke InjIn me ek ka:rboretʌr aur ek pʌmp haI.

(The engine in this tank has a carborater and a pump)

9) ha:syka:rō ke ek sʌmu:hʌ ne pa:rlIment ke ba:re ek ha:sy vyʌŋ kIya

(A group of comedians has staged a parody of the parliament)

10) tumhare dɔktʌr ne kʌha ki tumhare donō ha:tʰ ṭu:t gʌye haĪ.

11) cʰoṭi lʌḍki pa:rk ke pa:s ke pura:ṇe hoṭʌl me so:tI haI.

12) nʌgʌrpa:lʌk kehete haĪ kI unkI ~~donō~~ pa:rtI sʌbse mʌjbu:t haI.

(The village head says that his party is the strongest of all)

13) redIyo ka sangīt mere cacere bʰa:I ko jyada a:dʰu:nIk lʌgta haI

(The music on the radio is too modern for my cousin)

14) lʌḍkI ne tʰoḍa sa roṭī aur ek cʌmʌc cʌtnI kʰa:i haI

(The girl has eaten some chapatti and a spoonful of chutney)

15) Is anuda:n ko jīv vIgyan me ucc ṡIkṡa lene vale yuvʌ vaIgyanIk ko prʌdān kIya

(This grant shall be awarded to a young scientist specialising in biology)

APPENDIX-IB

Sentences used in English used in the time compression task

1) The long pathway that leads to the see is really pretty.
2) The program on the television is based on a true story.
3) The discussion is always centered on the problems of economy.
4) The paper says that the president arrives in town this month.
5) The girl has chosen her blouse in the supermarket in town.
6) Paul had a glass of wine at the end of his dinner.
7) The policemen chases the burglar on the roof of the bank.
8) The engine in this tank has a carborater and a pump.
9) A group of comedians had staged a parody of parliament.
10) Your doctor has said that your two arms are broken.
11) The young girl sleeps in the old hotel near the park.
12) The Mayor says that his party is the strongest of all.
13) The music on the radio is too modern for my censin.
14) The girl has eaten some bread and a spoonful of marmalade.
15) This grant shall be awarded to a young scientist specialising in biology.