SPEECH IDENTIFICATION TEST FOR
KANNADA SPEAKING CHILDREN

Reg. No. M9723

Independent Project submitted as a part of fulfillment
for the first year M.Sc., (Speech and Hearing)
to the University of Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE - 570 006
1998

DEDICATED TO
AMMA AND ANNA

your love, support, constant encouragement and faith in me are the main stay of my life. You have given me the courage to dream and believe in them. Every day, I thanks GOD for dear ones as precious as you.

CERTIFICATE

This is to certify that this Independent Project entitled ***SPEECH IDENTIFICATION TEST FOR KANNADA SPEAKING CHILDREN*** *is the bonafide work in part fulfillment for the degree of Master of Science (Speech and Hearing) of the student with Register No. M9723.*

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Mysore
May, 1998

CERTIFICATE

This is to certify that this Independent Project entitled ***SPEECH IDENTIFICATION TEST FOR KANNADA SPEAKING CHILDREN*** *has been prepared under my supervision and guidance.*

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May 1998

DECLARATION

This independent project entitled **SPEECH IDENTIFICATION TEST FOR KANNADA SPEAKING CHILDREN** is the result of my own study under the guidance of **Dr. Asha Yathiraj,** Reader, Department of Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other diploma or degree.

Mysore
May, 1998

Reg. No. M9723

ACKNOWLEDGEMENTS

I express my sincere gratitude to my guide and my teacher **Dr. Asha Yathiraj,** Reader, Department of Audiology for her patience, constant support and guidance throughout this project.

I am thankful to **Dr. (Miss) Nikam,** Director, All India Institute of Speech and Hearing, Mysore for permitting me to carry out the study.

I am indebted to all my **Teachers** for the foundation they have given and the faith they have in me.

I thank **Mr. Ganeshaiya** for lending his artistic talents to develop the test material.

I would like to extend my sincere gratitude to **Dr. Subbukrishna,** Lecturer in Central Institute of Indian languages for his timely help in developing the test items.

I am indebted to **Dr. Prakash,** who inspite of is busy schedule helped in my statistical analysis.

I extend my sincere gratitude to the Headmistress of Gangotri school, Mount Convent English School, Kaveri School, Gnana Ganga English School, who obliged in providing subjects for the study.

I am grateful to all the parents for allowing me to do the testing on their young ones.

A special thanks to all the buddies who co-operated in testing and made this project a reality.

I am thankful to **Mr. Basavaraju and Mr. Shivappa** for xeroxing the test materials, in spite of their tight schedule.

Chintu and Mintu : Words cannot suffice what you mean to me. You both are my greatest possessions.

Meera Aunty, Uncle, Kamalesh and Sony - Thank you for your hospitability, love, and encouragement you have given me during my stay at **AIISH.**

Viji, Arthi Kutti and Jayashree - You are someone on whom I can always depend on. Whenever I think of you, I think of a very special friend who makes my world a better place to live in.

Suman, Reena and Viji - Friends are living treasures. One of the most valuable gifts of life. You have made my memories in AIISH cherished one and have been friends beyond compare.

Anjana, Radhika, Hia and Sanyu - Thanks for listening, talking, understanding and comforting me, for giving me strength in my times of need and for sharing with me my happiness and excitement. Friendship is a promise spoken by the heart. A promise we will always share.

Aniket, Chandan - Thank you very much for helping me in my Academics.

Manoj, Eliza, Hari, Kanaka, Priya, Veena, Poonam and Sonia - Thank you very much for your tremendous support and help during the course of my study.

Sreedevi and Pallu -In this busy world, not many people extend their helping hands. Thank you very much for helping me in my data collection.

Kool Kats - Ruchi, Neetu, Pallu and Sarmi. You are the kind of friends I would like to be to others. I miss you all a lot.

Akila - The very little time, I have spent with you where the times I loved most. Thank you for all those beautiful moments, especially your friendship which has added whom to my life.

Purnima, Jayaradha, Prachi and Sapna - Thank you very much for lending me a helping hand whenever I needed. I am indebted to you all.

It is people like you
Who make this world
A better place to live in

Suja and Anitha - You both mean to me a lot so does your friendship. Hope we remain friends for years to come.

I thank all my classmates for the moral support you have given me.

I am grateful to **Mukundan, Srivatsan, Selvarani and Arul Devi** for helping me during the project.

I would like to thank everyone who directly or indirectly helped me in my project.

Last, but not the least, I would like to thank **Softouch Computers** for their timely help. Its your accurate stroke on the key board which has given life to the project of mine.

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INTRODUCTION

Hearing is the avenue for communication and majority of what we learn throughout lives occur through hearing and speech. (Rupp, 1980)

The human ear is marvellously complex and intricate mechanism. Fully developed at birth, it is prepared immediately to react to sound stimuli ranging from very faint to very loud sounds and to the whole range of frequency that are meaningful to human environment. From birth, the growing child begins the process of adaption to environment by means of sensory experience. Before children learn to assimilate and interpret visual symbol, they have much earlier learnt to interpret acoustic signal. Ears are finely tuned to our human needs that, we can constantly monitor our environment ignoring unwanted sounds, but listening selectively to many relevant sounds for our normal functioning. (Nerbonne, 1989)

Thus, speech can serve not only as a test for communicability, but also as an extremely handy representative signal with which to examine the ears.

Speech audiometry is an important element in the audiological test battery. It has come into existence because of some inherent advantage over pure tone audiometry. Every day listening situations does not involve the ability to detect sound. Pure tone audiometric results provide information on detection of the sound of certain frequency and intensity but not on the receptive auditory communication of the individuals which is given by speech audiometry. Also, speech audiometry helps in early detection of slight losses which are otherwise over looked. The need for speech audiometry arises mainly because, speech is by far the most important class of sound that one hears.

"Today's children are tomorrow's citizen" is a saying, young children commonly exhibit delay in language development because of hearing deprivation. Language retardation and vocabulary limitation makes children handicapped to live in this world. "Prevention is better than cure". Here prevention refers to the early identification and rehabilitation of the disability. Early identification and rehabilitation will bridge up the gap between disabled child and the normal child in language development. The uniqueness of children in this world led to the development of conducting audiological evaluation. The audiological assessment will provide information regarding the communicative handicap imposed by the hearing loss, it assists in selection of appropriate amplification and serves as one of the basis in developing an aural rehabilitation program.

Justification For Development of Speech Test For Children

Among the clinical population, it is found that paediatric population are difficult to assess. Hardy and Bordley (1951) pointed out that, children pay closer attention to verbal stimuli than to nonverbal stimuli. Bunch (1934), reported that speech items have higher face validity than non-speech items. Clawson (1966), observed that mentally retarded children show an arousal to speech stimuli *at* significantly lower level than they do for pure tones. Olsen and Matkin (1979), found that children find speech tests easier and less abstract than pure tone tests and are willing to participate. The above reason proves the use of speech as stimuli for assessing young children.

Justification for the Use of closed Response Mode in Assessment

Usually speech test involves verbal or written responses. Oyer and Doudna (1970), commented most of every day situation require closed set monitoring skills, the open-set responses will not be possible for paediatric population because of the following reasons:

1. Children have a low level of language compared to adults. So adult speech material cannot be used with them.
2. Written responses are not possible for their age.
3. Children with hearing loss exhibit articulatory problems which makes their oral responses unintelligible to the examiner.

In order to avoid above mentioned difficulties, a psychomotor approach can be employed which involves picture pointing or an object selection task.

Several tests have been developed which employ either a picture pointing or an object selection task. These include tests developed by Ross and Lerman (1970); katz and Elliott (1978); Moog and Geers (1990); Olsen and Matkin (1979); Rout, (1996) and Mathew (1996).

Need For The Development of a Kannada Speech Identification Test

When speech is used as a stimuli for assessment, the language used for testing becomes an important variable (Alusi et al. 1974). It is preferable to use materials in the individuals native language when his or her speech identification ability is to be assessed. This is because, an individual's perception of speech is influenced by his first language or mother-tongue. (Singh, 1966; Singh and Black, 1966 and Gat, 1971). This could be explained based on the fact that, when an individual learns his native language, he not only learns to speak but also learns to listen in the same manner. To satisfy this condition, a number of attempts have been made at the construction of speech identification tests in different language such a Arabic (Alusi et al. 1974; Ashoor and Prochazka, 1982), Hindi (Abrol, 1971) ; Malayalam (Mathew, 1996), Tamil (Kapur, 1971 and Samuel, 1976), Bengali (Ghosh, 1988) and English for Indian children (Rout, 1996).

India being a multilingual country with fifteen official languages and 1652 dialects (Manorama year Book, 1996), makes it necessary to develop test for the paediatric population in all Indian languages.

Thus, the present study aims at developing a speech identification test for kannada speaking children of age group of 3.5 years to 6.11 years. The test will be a bisyllabic, closed-set picture test using a picture pointing task.

IMPLICATION OF THE PRESENT STUDY

The developed test, thus, would be useful in evaluation and fitting of hearing aid for children whose language age is 3.5-6.11 years.

The same test material could be also useful to evaluate the speech perception ability in adults with low level language, individual with inadequate speech and mentally retarded individuals, provided their receptive language age lies between 3.5 to 6.11 years.

Aim of the study

The present study was conducted to find the following :

1. The relationship between presentation level and speech identification scores.
2. The effect of an age on speech identification scores.
3. Whether the half list is equivalent to the full list.
4. Reliability between the lists.

REVIEW OF LITERATURE

The ability to communicate meaningfully and to understand speech has been considered as an important factor in differentiating humans from other forms of life. (Sanders, 1982). Almost from birth, an infant begins the process of learning language which forms the basis for the other aspects of development. An infant with adequate hearing will learn language skills primarily through the auditory channel communication of thoughts and ideas are essential for natural learning of language. Even though communication can occur through pointing, writing and gestures, speech is the most often used way to communicate with the immediate environment. Thus, it forms the prerequisite for effective participation in our complex auditory world. (Martin, 1987).

The on set of auditory impairment in an individual impedes the ability to communicate meaningfully and to understand speech. Therefore, it is the foremost duty of an audiologist to evaluate and rehabilitate these aurally handicapped individuals.

Speech Audiometry - A major Assessment Tool.

Various stimuli like puretone, speech, environmental sounds etc., are used to evaluate the hearing ability. Speech stimuli have been used in evaluation of hearing ability as early as 1874 by Wolf. According to him, "Human voice is the most perfect conceivable measure of hearing". The otologist also used tests which make use of speech such as whispered speech test and voice test for hearing evaluation. Over a century ago, prior to the introduction of audiometry, speech was considered as a major assessment tool. Bunch (1934) reported that pure tones produce low percentage of responses and are not as effective as speech. Assessment of hearing using puretones provide information regarding the sensitivity but not on the receptive auditory ability (Elliott, 1963; Harris, 1965 and Marshall and Bacon, 1981).

Uses of speech tests :

Speech stimuli have become indispensable tool in clinical evaluation.

1. They have been used to confirm pure tone threshold

2. A discrepancy in the threshold of hearing and the threshold Of intelligibility indicates functional hearing loss (Ventry, 1976).

3. Speech discrimination abilities are found to be distured in centrally placed auditory pathologies which are not manifested in peripheral hearing loss, but can be found using a speech test (Jerger and Jerger, 1974 and Jerger & Haynes, 1971).

4. Higher auditory function can be tested using filtered speech test (Bocca & Calero,1963, Willeford, !969 and Hodgson, 1972) and time compressed speech test (Luterman, Welsh and Melrose,1966; Beasly, Schwimmer and Rintelmann, 1972).

5. Speech materials are also used in hearing aid selection, prescription and rehabilitation (Markides, 1977).

Thus, speech stimuli act as versatile stimuli and speech audiometry can be considered as a major assessment tool in diagnostic audiology.

Different types of speech test :

Using speech stimuli, an individual's speech detection threshold, speech reception threshold and speech identification scores can be found.

SPEECH DETECTION THRESHOLD is the lowest level at which speech can be detected. While, SPEECH RECEPTION THRESHOLD is the intensity level at which the listener can repeat 50% of the material presented. However, these measures do not talk about an individuals understanding of speech. The speech test which determines the listeners ability to understand speech under ideal listening situations are speech identification tests.

Various other terms used analogously with speech identification are Articulation, Discrimination, Intelligibility, Understanding, Perception and Recognition (Penrod, 1994).

WHAT MAKES A GOOD SPEECH TEST ?

A good speech test should be able to evaluate an individual's speech understanding capability in a real life situation.

In a real life situation, certain factors like noise in the environment, rate of speech, multiple speaker situation affect speech understanding ability. A speech test which is used in a clinical set up should aim at evaluating an individuals hearing capability as in a real life situation. Thus, a speech test should consider the following variables when it is being constructed :

Variables to be considered during the construction of the test :

1. Type of test material
2. Number of lists used
3. Phonemic Vs Phonetic balancing
4. Word frequency
5. Word familiarity
6. Language of the target population
7. Contextual effects

Variables to be considered while presenting the test item :

1. Live voice Vs Recorded voice
2. Use of carrier phrase
3. Single Vs Multiple speaker
4. Presentation level
5. Type of Noise
6. Reverberation Time
7. Distortion using time compression and filtering

Variables to be considered while administering the test :

1. Instruction and Reinforcement
2. Rate of presentation
3. Responses mode
4. Representation of the score

VARIABLES TO BE CONSIDERED FOR THE CONSTRUCTION OF TEST ITEMS :

Type of test material

Speech identification test results will vary depending on the type of material used. Nonsense syllables, Monosyllables, Bisyllables and sentences are some of the materials used to test the speech identification ability of an individual.

Non sense syllable

Non sense syllables can be used to test speech discrimination ability. The advantage of non sense syllables over other materials is that the linguistic cues that contaminate the test performance are eliminated when non sense syllables are used. They are independent of the listners vocabulary (Berger, 1971). They are non-redundant (Carhart, 1965) and are easier to construct than meaningful material (egem, 1948). But non sense syllables have their own draw backs. So, the use of meaningful stimuli was recommended in preference to non-sense words. Non-sense syllables are abstract and very confusing to the listener. The tester needs special training to read out the words in the intended way (Carhart, 1965).

Monosyllabic words

Monosyllabic words are less analytic unit of speech and are more easily repeated than non-sense syllables (Egan, 1948). Monosyllables are preferred because they are non-redundant and are meaningful (Carhart, 1965). Also, they are not as confusing as non sense syllables (Carhart, 1965). Mono syllables can be easily manipulated to represent colloquial speech (Giolas, 1975). It enables the tester to determine the articulation function rapidly (Boothroyd, 1968).

A number of monosyllabic word list have been developed for the paediatric population. The popular ones are : The phonetically balanced kindergarten 50 (PBK 50) (Haskins, 1949) word intelligibility by picture identification test (WIPI) (Ross & Lerman, 1970 and Lerman, Ross & Mc Lauchlin, 1965), the Northern western University - Children's perception of speech (NUCHIP) by (Elliott & Katz, 1980). In India, a monosyllabic word list for children in English was developed by Rout in 1996.

Bisyllabic words

The development of bisyllabic list for speech discrimination testing is mainly due to language restriction. That is, some languages do not have concrete monosyllabic words. They are less analytic than mono syllables and provide additional cues for intelligibility. They can be identified not only on the basis of phonetic elements but also on the basis of stress patterns (Hirsh, 1952). Comstock & Martin in 1984 developed children's Spanish word discrimination test which could be efficiently administered by English speaking clinicians to Spanish speaking children.

Rhyme words

Rhyming words have also been used as test material to test the discrimination ability. Knafle (1973) developed a rhyme test for children. He found that children had difficulty to select rhyming words that required differentiation at the end of the word. But visually the last letters can be more easily discriminated (Marchbanks & Levin, 1965 and Jenkins, 1963). Care should be taken when interpreting the result across modalities.

Distinctive features

Mc.Pherson and Pang-ching (1979) developed a distinctive feature discrimination test for adults. Here the error responses were evaluated in terms of their distinctive feature differences from the stimulus item.

Merklein (1981) developed a short speech perception test (SSPT) for severely and profoundly deaf children which incorporated 'distinctive feature' elements in a minimal contrast, forced choice and word picture format. It tested 10 distinctive features.

An advantage of the speech discrimination test using distinctive features over other test is that they not only give quantitative account of speech discrimination but also qualitative analysis of error patterns. Thus, they help in knowing the most frequent perceptual error and help in planning appropriate rehabilitation strategy for the hearing impaired.

Sentences

Sentences are considered to be more valid indicators of intelligibility. But they are not typically used to assess word recognition clinicians should use larger linguistic units such as sentences to assess intelligibility, since they are a better representation of spoken communication. The use of single words, especially single syllable words, impose severe limitations on the capacity to manipulate certain patterns like intonation & coarticulation effects on the ongoing speech. Eventhough sentences represent the spoken communication, they are not frequently used, because it they are difficult to construct.

Kent state university speech discrimination test (Berger, 1969) was found to be less sensitive to predict hearing impairment. However, they can be used to predict how efficiently one could use hearing for communication purpose. Other tests which use sentences as 'speech stimuli are paediatric speech intelligibility test (Jerger, 1982).

Other stimuli : Apart from this, other stimuli like numbers, sounds and Alphabets have been used to assess discrimination ability. Few examples of such tests are sound effect recognition test (SERT) by Finitzo - Hieber et. al., 1980, Auditory number test (Erber, 1974). Test of Auditory perception of Alphabet letters (APAL) (Ross & Randolph, 1990) and Early speech perception Test (Moog & Geers, 1990).

Phonetic Vs Phonemic balancing in word lists :

The speech tests are constructed using phonemically or phonetically balanced word list. Phonetic & phonemic balancing plays a role in speech discrimination score. Egam (1948) said that a test is phonetically balanced if it has speech sounds that occur in every day speech. Another way to obtain balancing is to use word lists which contain same proportion of phonemes in each list (Booth royd, 1968). The score obtained for each phoneme can then be weighted by its frequency of occurrence in everyday speech. A phonemically balanced list refers to the test material having frequently occurring phonemes of a given language.

Most of the speech tests use phonemically balanced word lists. The rationale for using a phonemically balanced word list is that, if the listner is impaired, the scores got through a phonetically balanced list will identify his problem severely because the individual will have more problem in perceiving the sounds which occur less frequently, whereas a phonemically balanced list will measure his exact communicative difficulty. (Dillion and Ching, 1995).

All the speech tests aims at assessing an individual's communications difficulty. So, it can concluded that phonemically balanced lists would be preferable than phonetically balanced lists.

Number of lists :

In clinical practice, one rarely needs a larger number of lists. If articulation curve of an individual is to be obtained, then several lists are required. It is important that the same list should not be used more than once for an individual, because the scores may be contaminated with memory and practice effects (Tillman and Carhart 1963). Dillion and ching (1995) have suggested an alternative way. This is to use equivalent lists so that any item will be presented once. The greater the number of equivalent list available, the more flexibly the test can be applied.

Malani (1981) studied the inter list differences using form A of NU. 6 on Indians she found no significant difference between the list at higher sensation levels. Katz & Elliott (1980) used four test forms each including the same fifty mono syllabic nouns in different randomization in their NU-CHIP test. The four test forms upon statistical analysis were found to be equivalent.

A good speech test should have several phonemically balanced lists. This in turn would help to overcome practice effect.

Word frequency effects :

Word frequency effect is one of the variable that affects speech discrimination scores in children when compared to adults. Word frequency effect means, even though children have enough vocabulary, adults have much greater experience with stimuli and consequently require less acoustic information for correct performance.

Elliot and katz (1980) found that monosyllabic words that had been determined to be familiar to 3 year old children were much easily perceived by adults than by young children and hypothesized that this was attributable to type of word frequency effect. In other words, they suggested that even though both 3 year olds and adults are familiar with a word such as 'dog', the number of occasions when adults have heard 'dog' is far greater than exposure of 3 year old to the same word. They proposed that this type of phenomenon accounted for the finding that inorder for 3 year old to perform with near 100% accuracy, the stimulus item had to be presented at a level approximately 20dB higher than the level required for adults, eventhough all the stimulus item are familiar to the 3 year old children Elliott, clifton & servi, (1983).

Elliott, clifton & servi (1983) modified the 4 alternative forced choice picture pointing task, in which the test items were retained & the three alternatives were substituted by low frequency words. The test was administered to 54 children divided into 3 groups on the basis of pea body picture vocabulary best scores and also they had a 4th group, which consisted of adults. All the groups performed better on the modified test. However, difference was minimal in children with lower Pea body picture vocabulary test scores. But according to Broadbents hypothesis which states 'Response bias will be to wards words having high frequency occurance when differences in word frequency are present'. Based on this hypothesis, they should have responded to familiar pictures. This shows that frequency effect also depends on the language of the subject. Thus, the language ability of children should be considered as a variable in constructing a closed response test.

Also, the difference in performance between adult and children in regular material was found to be larger than the performance differences between regular and modified materials. This shows that adults employed more efficient strategies for processing the acoustic stimulus information than children. The years of listening experience and possible maturational development produced permanent changes with in adults, that enabled them to respond correctly to these materials at stimulus levels considerably lower than those required for children.

From the above study, it can be concluded that language ability and the listening experience of the subject should be considered when developing a test for a particular target age group.

Familiarity

Words which are encountered more frequently in real life situations, tend to recognised better than words which are not. The familiarity of a word needs to be viewed in the context of the people to whom the test is administered. The words which are infrequently used in general language will not be familiar to most of the people, even the words used frequently may not be familiar to young children. The familiarity of words, to the target subjects, will have several effects on the difficulty of the speech test. First, if a test contain high proportion of relatively unfamiliar words, then the total score will be lowered than if more familiar words have been used. Second, if word familiarity, is on average, higher in one list than in another, then the equivalence of list for difficulty will be adversely affected. Thirdly within a list, the range of familiarity of words will affect the range of difficulty of items with in that list (Dillion and Ching, 1995).

Several researchers have studied the effect of familiarity on discrimination score. Owens (1961) reported "If the stimulus is familiar word, it is likely to be prominent among those competing response and is quiet likely to be chosen. On the other hand, if the stimulus has low familiarity, it is unlikely to be among the competing responses.

Rosenzwing and Postman (1957) described the mechanism of the effect of familiarity on intelligibility when the stimulus word is masked in noise, only a part of it is discriminated and thesubject's language tends to favour a small number of competing responses relatively high in frequency of occurence.

Owens (1961) studied the relationship between word familiarity and intelligibility of seven monosyllabic word lists, which were divided into groups of three, two and two. The lists of each group were phonetically matched and varied systematically with respect to familiarity. The lists were distorted using low pass filtering & it was seen that there was a greater intelligibility score for more familiar lists. Also, it was found that discrimination errors increased as distortion increased and was greater for the unfamiliar list, while the intelligibility remained relatively undisturbed and slightly distorted for familiar list. Schultz (1964) reported a marked tendency for highly familiar words to be substituted for incorrectly identified words.

Pollack, Rubenstein and Decker (1959) & Egan (1957) found practice effect reduced the influence of word frequency. But, discrimination tests are typically presented to a person in a clinical setting without practice. Owens (1961) stated that a person with high intelligence and superior verbal ability would find more test words familiar & can take greater advantage of available phonetic cues resulting in higher discrimination score than a person with lower level of intelligence and lower verbalability. Thus, for a person with reduced education level, it will be difficult if the test items are unfamiliar.

In general, all these studies recommend that the test items should be familiar to the target population.

Cross Language Studies :

Linguistic experience of a listner plays an active role in word discrimination score. Gat & Keith, 1978; Singh, 1966; Abramson & Lisker, 1967 & Sapon & Carrol, 1967, found that the direction and magnitude of errors that occur in perception are systematically related to spoken language of the individual. Specific articulation features of a given language can systematically influence perception.

In a study of vowels, conducted on Swedish and American listeners by Stevens et al., 1959, it was found that linguistic experience did not have an effect on the discrimination of synthetic vowels. Although, the vowels were phonemically distinct for one group and not for the other, the discrimination was found to be similiar for both the listeners.

Contrary findings were established in a study of consonants by Abramson and Lisker 1967. Discrimination was more accurate for these position on the stimulus continuum that corresponded to different positions on voicing boundaries for the language spoken by the subjects i,e. Thai or English.

Miyawki et al.(1975) found thatlinguistic experience significantly affected perception when meaningful speech stimuli were used. However, no such affect on perception of speech was seen, while using non-speech stimuli.

Gat and Keith (1978) studied the effect of linguistic experience on word discrimination ability of non-native and native speakers of English with 1 year and 3-4 yrs of experience speaking English respectively. It was found that in the absence of noise, both the groups had similiar scores. With increase in noise level, word discrimination score deteriorated more in the non native speakers compared to native speakers.

Spanish learners were found to be more capable of discriminating a Spanish contrast of consonantal voicing than English learners (Eilers, Gavin and Wilson, 1979 & streeter, 1976).

Oiler & Eilers (1983) conducted a cross linguistic study on English and Spanish learning two year old children. The results showed that both the groups of children found identification of native contrast much easier than identification of non native contrast. The results suggested that by age of two, normal children may have achieved awareness of their native phonology, an awarness that encourages them to ignore certain distinction that are not part of their languages contrastive meaning system.

Sinha (1981) studied the linguistic experience on auditory word discrimination scoring for seven native and fourteen non native speakers of Hindi. He found no effect of linguistic experience beyond exposure of five years on auditory word discrimination in quiet. But in presence of noise, the performance deteriorated for non native speakers when compared to native speakers of Hindi.

A knowledge of linguistic experience on word discrimination score is very important. Because, the results have an important implication for foreign students regarding class room seating placement. The implications are essentially important as sophisticated tests of central auditory function some of which utilize speech in noise are applied to children of learning disability, who may have spoken a language in which the test was administered until they go to school.

It is, therefore, important that a speech identification test should be administered using lists of words in a language that is known to the subject.

Contextual effects :

Speech is a highly complex acoustic signal. Context is highly constrained in real world exchanges. In spite of many sources affecting perception of speech, the linguistic rules such as phonological, lexical, semantic and syntactic rules will enable us to make intelligent gusses when part of acoustic signal is masked or missing.

Nittrouer & Boothroyd (1990), reported two types of linguistic context effects in speech recognition; the contribution of word context to phoneme recognition (Eg real words versus nonsense syllable and more frequently occurring words versus less frequently occurring words) and the contributions of sentence context to word recognition (eg. semantic and syntactic constraints). They found that children between ages of four years six months and six years six months and adults over sixty-two years demonstrated poor recognition scores than young adults for words and sentences. This degradation in scores seems to be attributable to an increased masking effect of noise for children and older adults. However, this increase in masking did not interfere with their abilities to make use of linguistic knowledge in perceiving speech. Both, children and the older group displayed abilities to use syntactic constraints of simple sentence to the same extent as young adults. Children showed lack of semantic constraints. When compared to young adults, whereas older adults demonstrated similiar knowledge of semantic constraints to those of young adults.

Speech discrimination tests employ either paired comparison context or language context. Paired comparison context uses semantic and phonological components of language but not grammatical components. But children generally make sound discriminations that involve grammatical cues. Another comparison between paired - comparison context and language context is the manner of response required. In paired comparison context, the child listens and formulates a judgment as to whether members of a pair are 'same' or 'different. In language context, the child is asked to select the picture of the test word from response plate containing pictures of that word and other similarly sounding words. By presenting a context with no grammatical cues, the child is confronted with a situation with he is unfamiliar and one which may not related to his ability to use discrimination to understand language (Schwartz & Goldman 1974). This is in support with Boothroyd & Nittrouer; 1990. Elliot (1979) using SPIN, reported nine year old children, children, scores for words in sentences with and without semantic constraints were degraded and for eleven to thirteen year olds, only scores for words in sentences with semantic constraints were degraded.

Schwartz and Goldman (1974) conducted a study on seveny-two nursery, Kindergarten and first grade children. The stimulus item was presented in 3 different contexts : (1) paired comparison context in which only a pair of words was presented (2) carrier phrase context in which same sentence was used to present test stimuli (3) sentence context in which four different sentences were alternated to present stimulus items. In paired comparison context, the child was required to point to the pair of pictures spoken, whereas in carrier phrase and sentence context, the child was required to point to picture of the target item. It was found that, significantly more errors were made in paired comparison context than in carrier phrase and sentence contexts. These errors were more in presence of noise.

Thus, the review of literature shows that adults tend to perform better both in paired comparison contrast & language contexts, while children usually perform better in language contexts.

VARIABLES TO BE CONSIDERED WHILE PRESENTING THE TEST ITEMS

Recorded Vs Live Voice Presentation :

The test material can be recorded and presented or it can be presented through monitored live Voice. Both recorded and live voice have their own advantages and pit falls. Live Voice is flexible, rapid and can be administered easily, especially with children and the aged. However, Live Voice presentation has its own disadvantages. The speech test scores depend on the talker [House et al., 1965, Penrod, 1979 and Hood and Poole, 1980]. Even for a particular talker, the manner in which the speech sounds are produced can affect the scores obtained [Brandy, 1966]. Random variation in the intensity or clarity of enunciation will thus decrease the test reliability. If the clinician has bias about which of several measurements should produce the highest score, then the clinician could consciously or unconsciously vary his or her clarity of presentation, either auditorily or visually across conditions to achieve the desired results [Gillion & Ching, 1995].

Recorded presentation prevents such biases. It ensures uniformity of presentation. But, the signals recorded will deteriorate overtime. Also, the interstimulus time interval cannot be manipulated. ASHA (1988), proposed recorded voice to be a preferred method for stimulus presentation. Olsen and Matkin (1979) reported that almost 65% of 281 respondents employ monitored live voice for testing word recognition ability. In busy clinical setting, monitored live voice is preferred.

Now a days, computers are used in speech audiometry which covers up the pitfalls faced by the recorded materials. Early application of computer to speech audiometry involved simple control over signal presentation level. (Wittich et al., 1971). Using computerized speech audiometry, signals can be presented at a pace that is consistent with an individual patient's response time and can be repeated with ease. These advantages are especially useful while evaluating children. By using a computer as a digital tape recorders, a live voice testing can be mimicked, and the procedural limitations inherent in conventionally recorded materials can be eliminated. Advantages of using a computer for speech audiometry include

1. Digital representation of signals therefore do not deteriorate overtime.
2. Sophisticated alternations such as time compression, can be made relatively easy.
3. Inter laboratory consistency will improve substantially.
4. Stimulus presentation can be easily randomized by the computer.

It can be concluded that presentation using computer in speech audiometry is advantageous over Live Voice.. Presentation. Among the three, recorded material was found to be least flexible.

Carrier Phrase :

Carrier phrase is one of the variables that has influence on speech identification scores. Use of a carrier phrase in speech audiometry is assumed to alert the listener for the test word and allows the announcer to monitor his voice, but usually the exact content of the carrier phrase is not considered important. [Egan, 1944; Carhart, 1952].

When a carrier phrase is spoken prior to a test word, the potential phonemic interaction affecting intelligibility is present. Further, different carrier phrases may produce different types or degrees of interaction, resulting in differences in intelligibility scores for the same test words.

Martin et al., (1962) discussed the non essentiality of the carrier phrase and they found that it only confused the listeners who had severe discrimination problems.

Research by Libermann et al., (1967) suggested that some features of a speech sound are carried by the preceding or the following sound that is coarticulation. This serves to increase the redundancing of signal, thereby providing the listener with the multiple cues. It is suggested that the acoustic characteristics of stimulus items in the carrier phrase were partly conveyed by sounds preceding and following the target sound, affording the listener more cues upon which to make discrimination.

Gelfand (1975) used CID W-22 word list on twenty-two to sixty-six year old adults. He found that the discrimination scores were five percentage points higher when a carrier phrase was included.

Northern and Hattler (1974) found that when a carrier phrase was omitted, discrimination scores were worse. They found greater chances of better discrimination with a carrier phrase. The use of a carrier phrase especially improves the speech discrimination score in subjects with sloping audiometric contours.

Gladstone and Siegenthaler (1972), used 3 carrier phrases "say the word ..." "you will say ...", and "point to the ...". for CID W-22 word lists. It was found that there was an enhancement of discrimination score with the carrier phrase. They found intelligibility with the phrase"you will say ..."

was best because the long vowel leil at the end. In contrast to other endings, it had greater potential for being influenced by the phonemes of the word to follow and gave additional cues to intelligibility.

Researchers vary in their opinion regarding the usage of a carrier phrase. However, a majorities of the researchers are for its use. Those favouring usage of it argue that a carrier phrase acts as an alerting signal and those not favouring its usage argue that it consumes greater time for testing.

While constructing a speech test, usage of a carrier phrase should be dealt carefully, since it plays a important role in speech discrimination.

Talker : Single Vs multiple talker

Peters (1955) and Creelman (1957) found poor performance in speech intelligibility task when lists were spoken by more than one talker.

Shankweiler and Edman (1976) showed that identification of naturally produced vowels were more accurate when stimuli were produced by a single talker than when produced by multiple talkers. Changes in voice from trial to trial affected perceptual processing and encoding of isolated vowels. Similar changes have been reported by Fourcin (1968) for consonants.

Cole, Colheart and Allfard (1974) found that the response latencies to 'same' judgements were slower when target words were produced by two different voices. Balota and Chumbley (1984) reported response latencies to be faster for words in single talker condition than words in multiple talker condition.

Mullennix, Pisoni and Martin (1989) reported similar findings as Creelman (1957). Pisoni and Martin (1986) conducted a study on three, four and five year old children using WIPI (Ross and Lerman, 1970). Subjects performed better on the single talker condition than multiple talker condition at all ages.

From the above literature, it is evident that it is preferable that a single talker be used to carry out a speech test, rather than having multiple talkers.

Presentation Level :

The effects of presentation level can be studied by employing performance intensity function. At low sensation levels, the scores will be poorer. With increase in intensity, the scores increase steadily. After a particular point, an increase in intensity does not bring about an improvement in the scores. This intensity level where asymptode is reached depends on the type of test material used.

Giolas (1975) obtained maximum speech intelligibility scores at 60dBSPL for CIDW-22 word list. Tillman et al., (1963) got almost perfect discrimination at 24dBSL for NU-4 test. However, Nerbonne, McMullin and Hipskind (1974) noted an asymptode at 40dBSL using Goldman-Fristoe wood cock test of auditory discrimination.

Various researchers have developed materials for speech identification tests for the Indian population and have obtained maximum discrimination score at 30-40dBSL either with reference to pure tone average (PTA), speech reception threshold (SRT) or Fletchers Average (FA).

Abrol (1971), Ghosh (1988) and Mathew (1996) observed maximum speech discrimination scores at 30dBSL using Hindi PB list, Bengali wordlist and Malayalam word list respectively. Kapur (1971) obtained the same results with Tamil word list at 35dBSL. Speech discrimination test in English for Indian population were conducted by Swarnalatha (1972), Mayadevi (1974) and Rout (1996). They obtained best scores at 30dBSL (ref SRT), 33dBSL (ref SRT) and 30dBSL (ref FA) respectively.

Clinically, most of the speech test use 25 to 40dBSL. 25dBSL corresponds to the beginning of the plateau where normal subjects obtain 90% scores and 40dBSL represents reasonable comfortable listening level for normal hearing individuals. So it is always preferable to do the testing at 30-40dBSL to obtain better speech identification scores.

Noise :

Noise is one of the factors that affect speech identification scores. Discrimination strongly depends on the kind of interfering signal with respect to its frequency response and time structure [Sotscheck, 1985]. The masking effects of noise depends on various parameters. These include its spectral pattern, its temporal parameters and the average intensity relative to the intensity of speech [Nabelek and Pickett, 1974].

Spectral Pattern :

There are different kinds of noise. Speech spectrum noise, complex noise, white noise and pink noise. Based on their band width, noise can be divided into Broad band and Narrow band noise [Olsen & Matkin 1991].

White noise :

It is a broad band signal containing acoustic energy at all frequencies in the audible spectrum upto 6KHz with equal intensities.

Speech spectrum noise :

It is a white noise filtered at low and mid frequency band, simulating the long term average spectrum of theconversational speech.

Complex noise :

It is a broad band signal composed of low frequency energy concentration. Pink noise is similar to complex noise.

Hawkins and Stevens (1950) studied speech intelligibility with a running speech sample under of different intensity levels of white noise and concluded that their noise signals that exceeded the speech signal by 8dB or more interfered with intelligibility of the speech signals. Rupp and Philips (1969) reported white noise to be more interfering in its effects than speech spectrum noise at the same dial setting. Masking is most effective by a noise which - has the same long term spectrum as speech (Penrod, 1994). Ivo (1983) found that wide band noise disturbs speech perception more than narrow band noise under same listening conditions.

Miller (1947) found wide band white noise superior to narrow band white noise because of its flat uniform spectrum. Hirsh (1952) reported shift in speech intelligibility scores with wide band noise (20-660Hz) compared to lowest (20-160Hz) and highest (5100-6000Hz) narrow band. This is because lower and higher frequency band have little speech energy.

He also conducted a study using eight different narrow bands over 135Hz-4KHz. He found that effective masking produced by various narrow bands was related to intensity of noise. With bands above l000Hz, the speech was recognisable when the signal was 18dB lower than the noise. Low frequency noise can mask the entire speech range, if the noise is sufficiently intense. Bands above 2400Hz were quite ineffective in masking speech.

From the review, it can concluded that the noise, whose band width falls with in the spectrum of conversational speech will be an effective masker.

Temporal patterns of noise :

Time varying noise interferes with speech perception and causes annoyance. Based on temporal parameters, noise can be divided into continuous noise, impulse noise and interrupted noise. Subjects with normal hearing are able to take advantage of brief reduction of the masker intensity. As the hearing loss becomes greater, subjects become disabled to take advantage of such fluctuations. (Festen & Plomp, 1990]. Speech perception for normal hearing listeners were more affected for continuous noise than interrupted noise [Festen & Plomp (1990) & Nabelek & Pickett (1974a)]. Stuart & Philips (1997) reported similar findings. Impulsive noise is rarely studied. Nabelek and Pickett (1974a) studied the interference of impulsive noise with speech perception for normal hearing listeners with and without a hearing aid. The conclusion of the study is that impulsive noise was more detrimental to speech reception than quasi steady noise.

Average intensity of noise relative to the intensity of speech :

The overall effects of noise on speech perception can be inferred from speech to noise ratio (S/N) expressed in dB. Speech recognition scores are generally high when S/N ratio is high and low when S/N ratio is low (Penrod, 1994).

Stuart and Philips (1997) studied the effect of presentation level on word recognition score in noise (continuous and interrupted) and in quiet at two sensation levels. Performance intensity function in both noise were determined at S/N ratios of 10, 5, 0, -5, -10, -15 and 20dB. There was no effect of presentation level on word recognition effects in quiet. Performance increased with increase in S/N ratio regardless of the type of noise.

Keith and Talis (1972) studied the effect of noise on ten normals, ten high frequency loss and ten flat frequency hearingloss subjects at 3 signal to noise ratio +8, 0, -8dBS/N. The normals performed better than high frequency hearingloss patients. Flat hearing loss subjects performed poorer. In quiet all the listners yielded better scores. Millis (1975) suggested that children require greater S/N ratio than adults in order to obtain similar speech identification scores.

A good speech test should be able to identify problems faced by individuals in real life situations. Noise is aby-product of human society. The presence of noise as a background factor in most listening conditions cannot be disregarded. Most human communication of verbal-symbolic nature is carried out in the presence of some measurable amount of noise.

From the review, we could see that, a speech test performed in quiet could not identify the individuals with difficulty, whereas, it could detect the pathologies in the presence of noise.

Reverberation :

According to Olsen (1981), Reverbertion is the persistance of sound in an enclosed space resulting from sound reflection within that space. Revebration is usually. Quantified in terms of Reverberation time (T) which is the time that would be required for the mean square sound pressure level, originally in steady state, to decrease to 60dB after the source stops. [Nabelek & Robinette, 1978].

Several investigators have studied the role of Reverberation on speech identification scores. Lochner and Berger (1964) and Nabalek and Robinette (1978) have indicated that the reflection of sound over a period of 0.02 to 0.03 sec enhance speech understanding ability. Normal human auditory system integrates the repetitive information over short periods and to some extent upto 0,08 sec thereby taking advantage of reflected speech sounds. These reflections do not improve speech. Understanding ability for hearing impaired listeners.

Kurtovic (1975) reported that reflections arriving 0.095 secondsafter the direct sound disturbs speech intelligibility in normals. Knudsen (1929) and Bolt and MacDonald (1949) predicted that speech intelligibility will be decreased when the Reverberation time reaches 0.35 to 0.4 sec. The similar line of findings were shown by Finitzo-Hieber and Tillman (1978).

Nabelek and Pickett (1974) found that small changes in Reverberation time from 0.3 to 0.6 sec could result in poorer scores on word identification task.

Nabelek and Robinson (1982) studied the children's perception in Reverberation sing modified Rhyme test and found significant difference between the performance of 10 years old children and adults under revebrant conditions. This they attributed to less listening skills in children.

Neuman and Hochberg (1983) studied the developmental changes in perception of speech by children under two revebrant times 0.4 and 0.6 seconds. Using non sense syllables. They found phoneme identification scores improved. With increasing age and decreased with increased Reverberation time. Children's performance in revebrant condition did not reach asymptote until age of thirteen. Loven and Collins (1988) results on children and adult was.that speech perception declined with increasing reverbertion time.

Binaural performance was consistently better than monaural performance under Reverberation condition [Neuman and Hochberg , 1983 and Moncur and Driks, 1967].

The above review reveals that Reverberation, influences speech intelligibility scores. Even a shorter Reverberation time, adversely affects the speech perception scores in hearing impaired subject. So Reverberation time must be considered as an important variable in clinical audiometric test situation. Hence, if audiometric testing is intended to stimulate real life situation, care must be taken in selection of material with appropriate Reverberation time.

Frequency Distortion :

The frequency range of speech extends mainly from 100 to 9000Hz, but even higher frequencies, upto 12000Hz may occur. A knowledge of language plays an important part in discrimination. With this knowledge, it is possible to fill in by guesswork, even major gaps in the signal heard, and to form an intelligible word or sentence [Fry, 1964]. Such knowledge seems to be poorer in younger children and mentally retarded than in normal adults.

Nagafuchi (1974) distorted the speech sounds by low pass, high pass and band pass filtering and presented to 20 normal children, 5 adults and 68 mentally retarded children. With unfiltered speech audiometry, 50dB SL was enough for normal children to discriminate monosyllables. As for mentally retarded, 10-20dB above average level of normal children was necessary to get correct discrimination. Discrimination was poorest with low pass filtering below 1200Hz. While discrimination was good for both the normal and mentally retarded with high pass filtering above 1700Hz. Owens (1961) found similar results with low pass filtering below 750Hz. This proved that the frequencies above 1300Hz are important for intelligibility of speech. The frequencies around 1500-2000Hz seem to be the most important for understanding of speech [Palva, 1965]. The study by Nagafuchi (1974) showed poorer scores in band pass filtering of 1200-2400Hz for both the groups, thus supporting Palva's finding.

Filtered speech test has proved sensitive in detecting central auditory dysfunction. Bocco et al., (1954), reported reduced performance in the control lateral ears for the majority of cerebral tumor patients. Lynn and Gilroy (1977) determined the sensitivity and specificity of low pass filtered speech in patients with temporal and parietal lobe lesion. He found the low pass filtered speech to be sensitive in detecting patients with temporal lobe lesion. Hence, from the above studies we can conclude that depending upon the type of the test, frequency component of the test material must be taken care.

Time compressed speech test :

There has been increasing interest shown by speech and hearing professionals in the assessment of auditory perceptual problems. Routine audiometric tests have been found to be insensitive to auditory perceptual disorder [Doehring and Rabinovitch, 1969]. This led to the development of a number of tests involving low redundancy speech tasks. One measure which apparently holds promise in the study of auditory perceptual abilities is time compressed speech. The clinical use of time compressed speech with children was first reported by Beasely et al., 1976. They provided normative data for children. Using Haskins phonetically balanced. Kindergarten list (PBK-50) by (Haskins, 1949) and word intelligibility by picture identification (WIPI) (Lerman et al., 1965 and Ross and Lerman, 1970).

Orchik and Oelschlaeger (1977) have demonstrated that children with multiple articulation disorders exhibit poorer performance. On time compressed speech discrimination test (WIPI) when compared to children with no articulation errors. Subsequent investigation with PBK-50 by Manning et al., 1977, indicated reduced performance on time compressed speech discrimination task by children displaying auditory perceptual deficits when compared to normal children.

Orchik, Holgate and Danko (1979) evaluated time compressed speech discrimination on Kindergarten children who were grouped according to the Scores on Lindamood auditory comprehension test (Lindamood, 1971). Word intelligibility by picture identification was administered at 0, 30% and 60% time compression. It was found that children demonstrating poor reading skills exhibited poorer performance on a time compressed speech discrimination task when compared to control group.

Beasley et al., (1976) using closed response task in time compression found that discrimination of monosyllables improved with age. Freeman and Beasley (1976) replicated these findings using open response format. Beasley and Rintelmann (1976) and Beasley et al., (1980) found similar results using time compressed sentences.

May, Rastatter and Simmons (1984) investigated the age related changes in discrimination of sentences 'presented under 50% time compression. Their findings suggest that optimal auditory processing capacity reaches asymptote at eleven to twelve years of age.

A good speech test should be able to diagnose lesion beyond the Cochlea such as an auditory perceptual disorder. It has been suggested that temporally distorted auditory stimuli could be used effectively in delineating subtle auditory processing problems [Jerger 1960; Calearo and Lazzaroni, 1957; Beasley et al., 1972 and Bocca and Calearo, 1963].

Competing Message :

During human communication, it is the verbal stimuli which interferes with conversation than non verbal stimuli like white noise, complex noise. Usually the background competing message would be speech of one or more talkers. To assess the communication difficulties of the hearing impaired person it would be appropriate to use a verbal stimuli as competiting message.

Several types of verbal stimuli has been employed as competing message. They are monosyllabic words [Carhart, 1965], Disyllabic words Babble (Miller, 1947), sentences (KaCena and Tillman, 1974) and continuous passage [Driks and Bower, 1969; Trammel and Speaks, 1970 and KaCena and Nicholls 1974].

When speech is used as masker, sentences are found to be better maskers than words [Carhart, 1965 and KaCena and Tillman, 1974]. Also, it has been found that sentences are better maskers than a background of continuous discourse (Dirks and Bower, 1969).

Miller (1947) and Triesman (1961) and conducted studies using known and unknown language ascompeting message. It was found that when two messages have same physical characteristic, language allows some selection between them. Phonetic cues which are different makes an unknown foreign language less distracting than a message which is phonetically similar to the language tested.

When different voices are used for test item and competing messages. It allows the irrelevant messages to get rejected much more efficiently than if only one voice is used.

Simhadari (1977) studied the effect of familiarity on the performance of subject in competing message task. It was found that discrimination scores were better when language of the competing message was not familiar to the subject.

The review of literature on compelating message shows that unfamiliar language and with different voice as a competing message will improve speech identification scores.

VARIABLES TO BE CONSIDERED WHILE ADMINISTERING THE TEST

Instruction and Reinforcement :

Researchers (Markides, 1979 and Eisenberg et al., 1966) have reported reinforcement and instruction given to the listner made a difference on speech discrimination score.

Children are usually distractive and have less attention when compared to adults, smith and Hodgson (1970) reported the use of token reinforcement [Candy, toy, money etc.) to maintain the interest in young children.

Eisenberg et al., (1966) conducted the Wepman Auditory discrimination test (Wepman, 1958) on Negro and White children. Some of these children made higher number of errors. In the second test form, the children were cautioned to listen better and were verbally rewarded for the correct response. He reported improvement in scores with special instruction and reinforcement.

Markides (1979), used 2 modes of instruction. In the first mode, children were asked to listen carefully and to repeat each word. In the second mode, they were encouraged to speak whatever they heard. His results showed improvement in scores with instruction than without instructions.

Sanderson-Leepa and Rintelmann (1976) suggested the use of tangible reinforcement with NU-6 stimulus material. They also suggested that this would increase childs attention to the test.

Correct speech discrimination scores can be obtained only when the individual pays attention to the test. An efficient speech test must have appropriate verbal instruction and reinforcement strategies for obtaining correct responses.

Rate of presentation :

Changes in speaking rate will alter the perception and categorisation of signal (Millers 1981). Johnson and Strange (1982) suggested that correct information about articulation rate is necessary to compensate for the incomplete acoustic specification which may occur at faster speaking rates. Study carried out by Sommers, Nygaord and Pison (1994) reported that recognition scores were better for single speaking rates than for mixed speaking rate. This was attributed to increased acoustic-phonetic variability which resulted in the poorer scores. Mullenix and Pisoni (1990) reported similar finding that is recognition scores were better at single speaking rate condition.

It can be concluded that the test items should be presented at a single speaking rate to obtain better discrimination scores.

Procedure Learning Effect

According to Theodoridis and Schoeny (1990), procedural effects include factors such understanding of the instruction and the expected response. If the test was administered in the presence of noise, procedure learning includes adapting to noisy listening situation and learning to extract every possible cues for identification of the test word. They studied the effects of procedure learning by presenting words under noise either in isolation or in the context of sentences. Their data in the context of sentences. Their data established firmly and effect of procedure learning on the performance of subjects during an hour testing session, when these subjects had participated in previous one hour session.

Procedural learning becomes an important variable when assessing central auditory function using complex stimuli.

Thus, when a speech test aims at diagnosing central auditory processing disorders. Using complex stimuli which requires. Performance of complex task, procedure as a variable learning should be considered as a variable.

Responses :

Subjects can indicate the perception of the test items either by pointing, selecting, repeating or by writing. There are two types of response mode. One is an open set response and the other is a closed set response.

Open set response :

In this response mode, an individual can either repeat the test stimuli verbally or can write down the test word.

Studies done by Mererill and Atkinson (1965), and Nelson and Chaiklin (1970) showed that the oral discrimination scores were always higher than write down discrimination scores.

Devaraj (1983) compared the oral and written response modalities and reported that written responses should be preferred whenever possible. Similar findings are found by Northern and Hattler (1974).

Closed response set :

Here the subject is required to point to the test item. In some cases, the test items are represented as pictures to which the subject has to point. For the test and administered using computer, the pointing can be via a touch sensitive screen or mouse or a key board (Dillion and Ching, 1995). Response biases in the closed set response can be controlled by using randomizedarrangement of pictures.

There are studies which compares the two modes of responses. (i.e. open set and closed set responses). Sanderson and Rintelmann (1971) found high scores using **WIPI** than on **PBK.** Both the tests gave higher scores than NU-6. The higher scores in **WIPI** was attributed to the closed set response mode as against the open set response mode of PBK and NU-6. They also suggested that the easiest task was a closed response to words, the next was a closed response to pictures and the most difficult was an open set response.

Olsen and Matkin (1979), reported that the closed set response could be used with mild Aphasia, cortical insult patient dysarthric and glossectomy patients. He also found that closed responses provided good estimates of word recognition performance.

The review, suggest that closed set response provide high scores than open set response. Since our everyday listening situation require closed set monitoring. It is preferable to use closed set response tasks.

Apart from the response modality and response scoring, the age of the subject, motivation, cooperation and associated problems like hearing loss, retardation, psychological, physical and emotional problems will also affect the speech identification scores.

Dillion and Ching (1995) gave two ways to represent the test scores. They are quantitative and qualitative scoring.

Quantitative Scoring :

Here the scoring can be done in any of the following ways.

1. Items can be scored as proportion of words or proportion of phonemes correct. Phoneme scoring will always lead to a higher score than word scoring because words cannot be correct unless all its phonemes are correct. The disadvantage of phoneme scoring is that it places additional demands on the concentration of the tester.

   When the material consists of sentences with several key words per sentence, scoring becomes difficult for the tester unless the subject is perceiving nearly everything correctly.

2. Another scoring method is to count complete sentences as test items. This occurs cover the response task requires the subject to follow an instruction or answer a question and then the subjects actions are judged as either right or wrong.

3. Scoring can be done by considering items into units, distinctive features [McPhreson and Pang-Ching, 1979]. This provides additional information about errors made.
4. A variation to counting items occurs in connected discourse tracking (DeFilippo and Scott, 1978). In this, the talker presents and represents words and phrases until the listner is able to repeat them correctly. In this case, the number of words per minute, rather than the proportion of words correct is scored.

Boothyord (1968) reported phoneme scoring to be 20-30% higher from whole word scoring. According to him, phoneme scoring reduces the influence of language function and interlist difference.

Qualitative Scoring :

Here the scores are represented either in percentage or threshold. The percentage of speech units correct is the most appropriate way to express the result. Whenever the purpose is to find maximum scores obtained under some specified condition. Qualitative rating can be used [Dillion and Ching, 1995].

Error analysis :

Diagnosis is not the ultimate goal of the speech test. A good speech test should be capable of assessing individuals disability as well as it should provide information regarding the rehabilitation program. Good procedural speech test will be capable of providing details regarding therapeutic aspects. Through error analysis, one can see the pattern of errors exhibited by an individual which inturn helps in remediation. Several error patterns seen in hearing impaired are : errors of consonants are more frequently substitutions than omissions ; omissions are more common for the final consonant than initial consonant (Oyer and Doudna, 1959). Voicing errors are rare, but errors do occur for both place and manner of articulation (Owens and Schubert, 1968), every hearing impaired individual does not exhibit the same type of error. Several investigators present error analyses in the form of confusion matrices. This provides information regarding the frequency of occurance of specific substitutions for various sounds. Stevenson (1975) devised a graph system for plotting the matrices. They represented place of articulation on Y axis and manner in X axis. Numbers can be used to indicate the error. Dots or other notations can be also used.

Depending on the type of the speech test, the tester can either select qualitative, quantative or error analysis to represent the scores achieved by the subject. The variables which affects the scoring of the responses are the language background and the training given to the tester.

Language background of the scorer :

Singh (1966) studied the influence of the subjects mother tongue on the perception of speech sounds. Two groups of subjects were tested. One group comprised of subjects whose native language was Hindi. The perceptual confusions of plosive phonemes were studied under two conditions of distortions, ie. temporal segmentation and filtering. There was a difference in two groups in recognizing voicing. Native speakers of Hindi responded erroneously more often than non-native speakers on the voicing feature. Results indicated that there was a difference in the perception of two groups.

Singh and Black (1966) also studied the influence of the subject's mother tongue on the perception of speech sounds. The subjects for the study were from four language groups : Arabic, English, Hindi and Japanese. The results indicated that the mother tongue affected the perception of speech sounds.

In contrast, Stevens et al. (1969) in their cross language study dealing with vowels found that linguistic experience had no effect. The subjects were Swedish and American listners. The stimuli used were synthetic vowels which were phonemically distinct for the one group and not for the other. The discrimination of both the groups was found to be same.

Elizabeth (1983) studied the effect of native language and training on scoring the response of speech discrimination test in English. She found that, there was no difference between the responses as evaluated by trained and untrained testers. This indicated that the training program did not help the individual to overcome the effect of a testers native language on scoring non-native speech discrimination test.

The review of literature brings to light that there are several variables that affect the outcome of thespeech identification test. These variables would differ depending on whether the test is being constructed for children or adults. The effects of these variables should be kept in mind when constructing a speech identification test.

METHODOLOGY

The aim of the present study was to construct and standardize a colored picture test of speech identification involving picture pointing task for Kannada speaking children in the age range of 3.5 to 6.11 years.

Subjects

Thirty subjects were taken for the pilot study and fifty subjects for the main study. The criterio chosen for subject selection were as follows :

1. All the subjects should be native speakers of Kannada and should be well exposed to the language.
2. They should be within the age range of 3.5 to 6.11 years.
3. They should have normal hearing.
4. They should not have any otological history.
5. They should have normal speech and motor milestones.

Instrumentation

A two channel, clinical audiometer, Madsen OB 822 with TDH-39 earphones housed in circumaural ear cushions MX-41 AR were used for testing. The calibration of frequency, intensity for pure tones and speech was done to confirm to ANSI, 1989 specifications. Calibration of frequency and intensity was also done for BC vibrator. Stable power supply to the instrument was ensured by a servo controlled voltage stabilizer.

Test environment

The data were collected in a sound treated two room setting. The ambient noise level measured, was found to be within permissible limits as recommended by ANSI 1991.

Development of the test material

The word lists used in this study consisted of picturable bisyllabic Kannada words which were within the vocabulary of 3.5 to 6.11 year old children. The test material were selected from the text books meant for the above mentioned age group. The word lists consisted of seventy words which were subjected to a pilot study to check the familiarity on Kannada speaking children of the target age group.

Pilot study

Familiarity for seventy words were evaluated on thirty subjects of the target age group. Each subject was tested individually. They were asked to name the picture depicting the items of the word list. A word was retained only if 85% of the children could name and identify correctly. Fifty three words were found to be familiar; out of which three words were utilized as practice items and fifty words as test items.

Construction of the Test Material

The test items were chosen so as to achieve phonemic balance. The frequency of occurrence of a phoneme was based on the data published by Ramakrishna et al., (1962). Test list A was constructed using fifty words. The order of these were randomized to construct test list B. List A' and B' are reverse orders of lists A and B respectively. For each of the test lists, a half list was constructed. The phoneme balance was maintained for both the full lists and half lists. A picture book was developed with four pictures on each page. Among the four picturized words, one was the test word and the other was a distractor word. The distractor word had the same vowel ending as the test word. The other two pictures were randomly selected.

Thus, the test material includes : four test lists A A', B, and B', the picture response book and a scoresheet. The two test list A and B (Appendix I) had the same fifty bisyllabic words in different random order and lists A' and B' are the reverse order of lists A and B respectively. The picture response book (Appendix III) was made in such a way that same book could be used for both the test forms. It also contained three pages for practice items. The practice items were not a part of test items.

The score sheet (Appendix II) contained the test items of each test form and the quadrant of the picture foil in which the correct items were located. (Quadrant I refers to the picture in the upper left Quadrant II refers to the picture in the upper right. Quadrant III refers to the picture in the lower left and Quadrant IV refers to the picture in the lower right). It also contains space for pertinent information about the patient.

Collection of Normative Data

Data collection were carried out at the Department of Audiology at the All India Institute of Speech and Hearing, Mysore.

Pure Tone Testing

Pure tone thresholds for both air-conduction and bone-conduction were obtained for frequencies from 250-8000 Hz and 250-4000 Hz respectively. The better ear was considered as the test ear for speech evaluation for each subject.

INSTRUCTION

The subjects were given instruction in Kannada in the following way-

"You will hear some words through the headphones. Listen carefully to each word and look at all the pictures on the page. Point to the picture of the word that you hear. If you listen carefully and point correctly, you will be given sweets."

ADMINISTRATION OF SPEECH IDENTIFICATION TEST

Two examiners carried out the speech test. One examiner presented the stimuli using monitored live voice ensuring, the deflection of VU meter to zero. A distance of 6-9 inches was maintained between the mike and mouth of the speaker a recommended by Penrod (1994). The other examiner was seated beside the child to help him/her turn to the appropriate page of the picture response book.

Initially, three practice items were presented at a comfortable level i.e. 40 dB SL relative to Fletchers Average (the average of two better thresholds among the speech frequencies, 500 Hz, 1 KHz and 2 KHz) (Rupp and Stockdell, 1980). The tests were administrated at 12 dB SL, 18 dB SL, 30 dB SL and 40 db SL relative to the Feltecher's Average. Both the order of the Test forms and the level of presentation were randomized using a random table (Linquist, 1970) for each subject. Each subject was presented list A and list B for two of the intensity levels. The same two test forms were presented in the reverse order for the other two intensity levels. No subject heard the test items in the same order more than once.

Scoring : The responses were recorded on a score sheet (Appendix II). Correct responses were given a score of two and incorrect responses were given a score of zero. The percentage of correct responses were calculated for each subject.

STATISTICAL ANALYSIS

The data collected on fifty subjects were analyzed. Using Analysis of Variance (Gravatter, 1987).

RESULTS AND DISCUSSION

The objective of the present study was to develop and standardize a speech identification test for kannada speaking children in the age range of 3.5 to 6.11 years. Fifty children whose mother tongue was kannada were evaluated.

The data collected on the subjects were analyzed with the help of repeated measures of ANOVA [Analysis of Variance] [Gravetter, 1987]. This was carried out to obtain the following information.

1. The effect of presentation level on speech identification scores.
2. The effect of age on speech identification scores.
3. To check the inter list variability.
4. Whether the half list is equivalent to the full list.

Effect of presentation level on speech identification scores :

The test materials were administrated at four presentation levels 12dBSL, 18dBSL, 30dBSL and 40dBSL relative to the Fletcher's Average.

The mean speech identification scores for all fifty children were 80.08% at 12dBSL, 86.68% at 18dBSL, 95.96% at 30dBSL and 98.68% at 40dBSL, with standard deviations 7.6, 3.6, 2.7 and 1.7 respectively.

Table 1 : Mean and standard deviation of speech identification scores across different presentation levels.

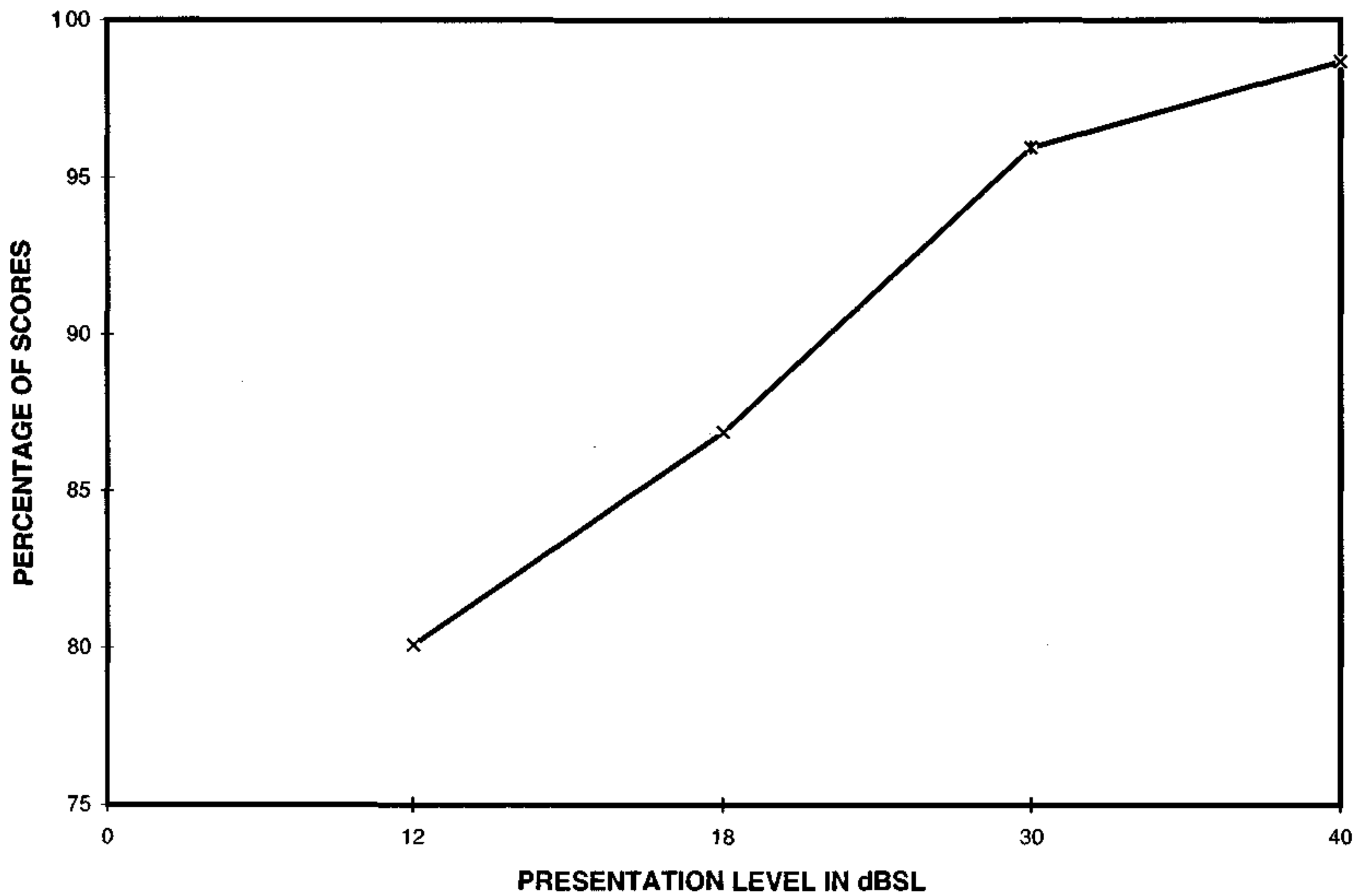
Group	Count	Mean	Standard deviation	Standard error
12	50	80.08	7.613	1.077
18	50	86.88	3.602	0.509
30	50	95.96	2.775	0.392
40	50	98.68	1.789	0.253

The results tabulated in table 1 show that speech identification scores were greatest at 40dBSL and lowest at 12dBSL relative to the Fletcher's average. There was a steady increase in the performance with increase in presentation levels. This could be due to the greater acoustic energy available to the subject at the higher presentation level. The above findings are in agreement with the studies carried out in the western countries [Tillman (1963); Carhart (1965) and Elliott and Katz (1978)] and in India [Malini (1981), Swarnalatha (1972), Mayadevi (1974), Rout (1996) and Mathew (1996)].

The articulation curve is drawn taking presentation level in dBSL along x axis and percentage of correct responses across y axis. The figure 1 shows that increase in presentation level, the percentage of correct responses increased.

As the presentation level increased, speech identification scores also improved. However, this performance intensity function was saturated at a particular level. In most of the subjects the maximum score (100%) was achieved at 40dBSL relative to the fletchers average.

FIGURE 1 : ARTICULATION CURVE



These findings in this study are in good agreement with other similar studies done in western countries [Tillmam (1963) and Carhart (1965)] and also in India [Abrol (1971), Kapur (1971), Samuel (1976), Swarnalatha (1972), Rout (1996) and Mathew (1996)]. All these investigators obtained the maximum scores (100%) at 30-40dBSL. However, Hirsh (1952) achieved maximum intelligibility scores at 60dBSL for CID W-22 word list. This could be because of the difficulty of the test items administered.

The standard deviation of scores at each presentation level tabulated in table I reveals an excellent picture of dispersion of scores at various levels. With increasing sensation levels, the standard deviation reduced. At lowest level i.e. 12dBSL, the standard deviation (σ1 maximum (7.6) indicating greater dispension of scores, while at 40dBSL with reference to Fletcher's Average, the standard deviation (Σ2) was least (1.8) reflecting less variance. This indicates that as presentation level increased from 12dBSL to 40dBSL, the scores became more uniform. At 40dBSL, the scores become more uniform. At 40dBSL relative to Fletcher's Average, the scores of fourty-nine out of fifty subjects ranged between 96-100% whereas, only one subject scored 92%. This could be probably due to the lack of few test words in the concerned subject's vocabulary.

The results of analysis of the variance test (Table 2) reveals a highly significant variance in the mean test scores across the presentation levels (F = 3, 147) = 236.958, P = .0001, significant at .05 level.

Table 2 : Summary of ANOVA findings

Source	df	Sum of Squares	Mean square	F test	P value
Between subject	49	1752	35.755	0.407	0.9998
with in subjects	150	13176	87.84		
Treatment	3	10918.24	3639.413	236.958	0.0001
Residual	147	2257.76	15.359		
Total	199	14928			

Based on the findings of the present study and that of other. Studies, it seems appropriate to administer the test at asupra threshold level, preferably 30-40dBSL relative to Fletcher's Average to generate subjects maximum response.

EFFECT OF AGE ON SPEECH IDENTIFICATION SCORES

Results and Discussion of Analysis of Mean score

The fifty children taken up for the present study were divided into four groups. The groups were a follows. The group I had children in the age range of 3.5 to 4 years; group II, 4-4.11 years; Group III consisted of children 5-5.11 years and Group IV had 6-6.11 year old children. At 12dBSL relative to Fletcher's Average, the group I obtained a mean score of 76% Group II 78.265%, Group III 84.2% and Group IV 84.8% (Table 3). Whereas at 40dBSL (ref:FA) Group I had a mean score of 97.2%, Group II 98.67%, Group III, 99.6% and Group IV secured a score of 100% [Table 6]. From the (Tables 3, 4, 5 and 6), we can see that at each presentation level, the speech identification score increased with age.

The standard deviation decreased with increase in age at all the four presentation levels.

Table 3 : Mean and standard deviation of speech identification scores for 4 groups of children at 12dBSL

Group	Count	Mean	Standard Deviation	Standard error
Three	15	76	11.563	2.986
Four	15	78.267	3.369	0.87
Five	10	84.2	2.7	0.854
Six	10	84.8	2.394	0.757

Table 4 : Mean and standard deviation of speech identification scores for 4 groups of children at 18dBSL

Group	Count	Mean	Standard Deviation	Standard error
Three	15	85.6	3.397	0.877
Four	15	86.133	2.669	0.689
Five	10	88	1.398	0.442
Six	10	88.8	1.333	0.422

FIGURE 2 : THE MEAN SPEECH IDENTIFICATION SCORES FOR THE FOUR AGE GROUPS AT 12dB AND 40dBSL RELATIVE TO FLETCHER'S AVERAGE

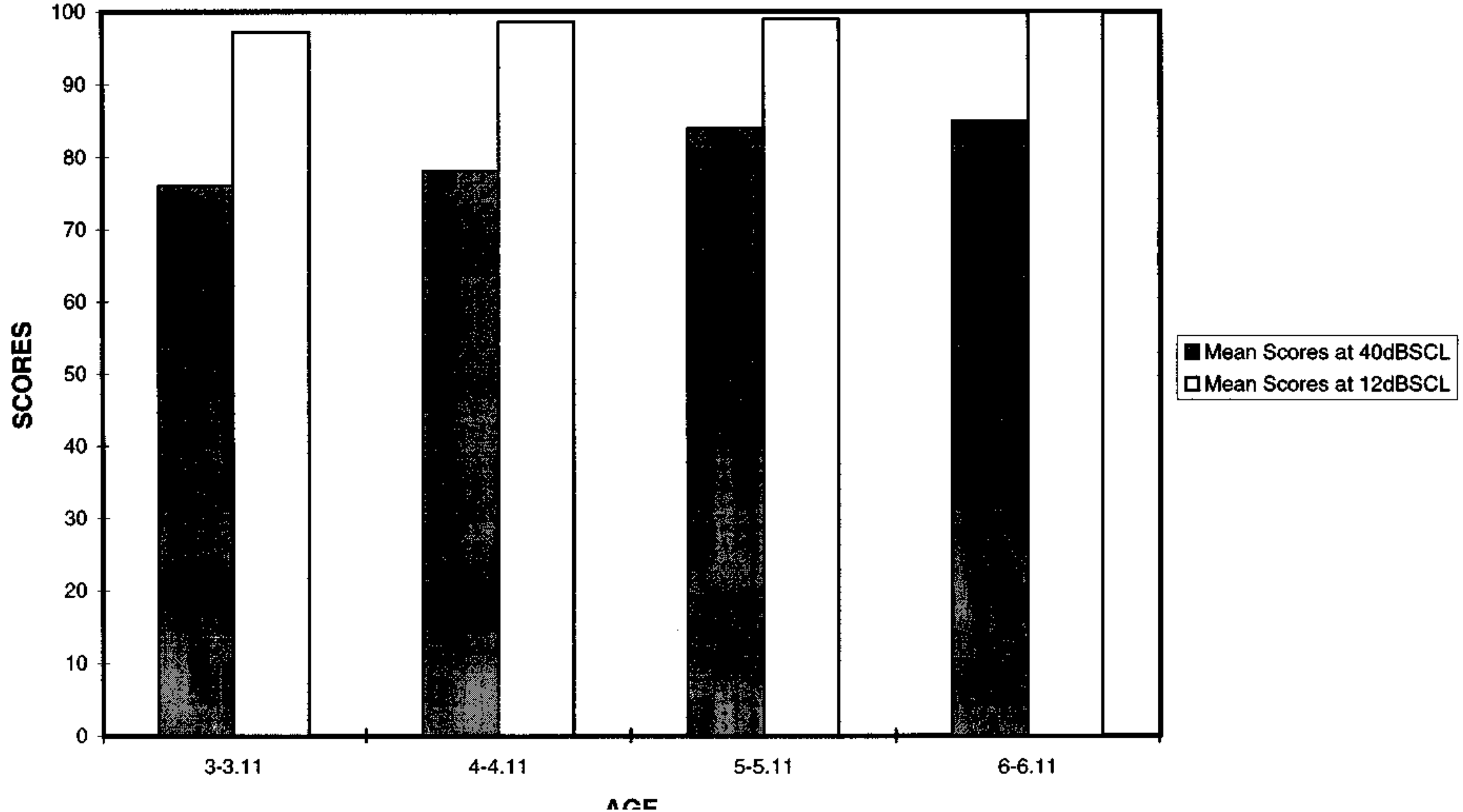


Table 5: Mean and standard deviation of speech identification scores for 4 groups of children at 30dBSL.

Group	Count	Mean	Standard Deviation	Standard error
Three	15	92.667	2.992	0.773
Four	15	96.533	2.7	0.661
Five	10	96.8	2.6	0.641
Six	10	99.2	1.3	0.442

Table 6 : Mean and standard deviation of speech identification scores for 4 groups of children at 40dBSL

Group	Count	Mean	Standard Deviation	Standard error
Three	15	97.2	1.971	0.059
Four	15	98.667	1.633	0.422
Five	10	99.6	.843	0.267
Six	10	100	0	0

The bar diagram (fig. 2) depicts the effect of age on speech identification scores at 12dBSL and 40dBSL (ref. FA). It can be seen that with increase in age, the speech identification scores increased. Similar results were obtained when the presentation levels were 18dBSL and 30dBSL (ref FA).

Results and Discussion of analysis of variance:

The ANOVA was established for the four presentation levels across four age groups. With increase in age there was significant increase in speech identification scores for all presentation levels (Tables 7, 8, 9 and 10).

Table 7. : Summary of ANOVA findings at 12dBSL for 4 age groups.

Source	df	sum of Square	mean square	f test
Between group	3	691.547	230.516	4.936
with in group	46	2148.133	46.699	P=.0047
Total	49	2839.68		

Table 8 : Summary of ANOVA findings for four age groups at 18dBSL

Source	df	sum of Square	mean square	f test
Between group	3	82.347	27.449	4.281
with in group	46	294.933	6.412	P=0.0095
Total	49	377.28		

Table 9 : Summary of ANOVA findings across four age group of 30dBSL

Source	df	sum of Square	mean square	f test
Between group	3	279.653	93.218	12.036
With in group	46	356.267	7.745	P= .0001
Total	49	635.92		

Table 10 : Summary of ANOVA findings at 40dBSL for four age **groups**

Source	df	sum of Square	mean square	f test
Between group	3	58.747	19.582	9.179
With in group	46	98.133	2.133	P= .0001
Total	49	156.88		

This is inconcurrence with other studies done by Elliott and Katz; 1978, Siegenthaler and Haspiel, 1966; Ross and Lerman, 1970; Mathew, 1996 and Rout, 1996.

Reliability of Half-list administration :

Many researchers have recommended using a half list for evaluating speech intelligibility [Carhart, 1965; Elliott and Katz, 1980] However, it is important that the half list should yield similar results as the full list. Hence the reliability of the half lists was evaluated.

The results of mean of scores for two half lists at 40dBSL were 98.71% and 98.9% [Table 12].

Table 12 : Mean and Standard deviation scores for half lists at 40dBSL.

Source	Mean	Standard Deviation	Standard Error
Fist half List	98.71	1.49	0.398
Second half List	98.92	1.32	0.36
Full list	98.5	1.39	0.35

The results of Analysis of variance revealed no significant difference between the two half list (Table 13). Also, the two half lists were not significantly different from the full list with had a mean score of 98.5%.

Table 13 : Summary of ANOVA findings

Source	df	sum of Square	mean square	f test
Between group	3	2.251	0.75	0.223
with in group	46	154.629	3.36	P=0.8798
Total	49	156.88		

An ideal test form should have both the half lists yielding similar results. The present word lists under study also revealed the same characteristic features. This reveals that the phonemic balance and familiarity of the two lists were similar. The statistical analysis revealed that one can administer the half list and get similar test results as that of full list administration.

The purpose of constructing half lists was to save clinical time, much relevantly to the Indian context, where one evaluates several subjects within a limited time span. The half list may be also useful while testing children whose attention span is not long enough to carry out the entire test.

In the present study, 50 bisyllabic words were presented in four orders. The four orders were A, A', B & B'. More than one list is required, when various parameters are being evaluated, such as effects of intensity, effects of training, effects of distortion of speech etc., It is important that all the forms should be equal.

The mean scores for four orders at 40dBSL relative to Flectchers Average (Table 14) were as follows :

Order A = 98.714%, Order A = 98.33%,

Order B = 98.92% and Order B' = 98.727%

Table 14 : The Mean and Standard deviation scores for the four orders at 40dBSL.

Group	Mean	Standard deviation	Standard error
Order A	98.714	1.49	0.398
Order A'	98.33	1.87	0.541
Order B	98.92	1.32	0.366
Order B'	98.72	2.5	0.766

The results of analysis of variance tabulated in Table 15 showed no significant difference between any order at 12dBSL, 18dBSL, 30dBSL and 40dBSL relative to Fletcher's Average F (3, 46) = 0.223 P = 0.8798. This indicates that the test can be administered using any of the orders given.

Table 15 : Summary of ANOVA findings for the order effect.

Source	df	sum of Square	mean square	f test
Between group	3	2.251	0.75	223
with in group	46	154.629	3.361	P =0.8798
Total	49	156.88		

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

1. With increase in intensity, the children's performance improved.
2. The highest score was obtained at 40dBSL (ref : FA).
3. With increase in age, the speech identification score increased.
4. The two half lists were found to be equal.
5. The two half list were found to be equal to the full list.
6. All the four form used in the study were found to be equivalent.

SUMMARY AND CONCLUSIONS

Research carried out by several investigators has shown that children perform better with speech stimuli when compared to pure tones (Bunch, 1934; Hardy and Bordley, 1951; Clawson and Matkin, 1970). It is always preferable that a closed set response involving a picture pointing task/object selection task be utilized rather than a open set response task (Ross and Lerman, 1970; Katz and Elliott, 1978).

The aim of the present study was to develop and standardize a picture pointing speech identification test for Kannada speaking children in the age range of 3.5 - 6.11 years.

A bisyllabic picturable word lists were constructed. The familiarity of the test items were evaluated on thirty children who were not the subjects in the final test. Only the familiar words were utilized for the test. The final list was constructed using fifty bisyllabic phonemically balanced words. Two lists A & B were formed using the same fifty words by randomsing them. The list A' and B' are the reverse order of lists A and B respectively. A picture response book with four alternative choices was developed.

Fifty Normal hearing children were selected for the present study. The test lists were presented at 12 dB SL, 18 dB SL, 30 dB SL and 40 dB SL relative to Fletcher's Average to the better ear of the subjects through headphones. The children had to point to the appropriate picture of the test item presented by the tester. The responses were scored. The data thus collected were subjected to statistical analysis using Analysis of variance.

The results of the present study were :

1. There was a significance improvement in speech identification scores with increase in presentation level.
2. With increase in age, there was a significant improvement in speech identification scores.
3. There was no significant difference between the half lists.
4. The mean scores of the half lists were equivalent to that of the full list.
5. There was no significant difference between the four lists with reference to the speech identification scores.

The following recommendations can be made from the present study:

1. The test developed can be administered to any Kannada speaking children of the target age group (3.5-6.11 years).
2. The test should be administered at 40 dB SL (ref.fA) to get better speech identification scores.
3. The developed material can be used for selecting amplification devices for the paediatric population.
4. The test material developed can be also used to monitor progress of an auditory training program.

RECOMMENDATIONS FOR FURTHER RESEARCH

Using the test material developed in the present study, the following research studies can be carried out.

1. Performing the test at different signal-to-noise ratios.
2. Standardizing the test on deviant population such as hearing impaired, mentally retarded and cerebral palsied children.
3. Using the same material diotic, dichotic, time compressed and filtered speech test can be developed for the paediatric population. This will be useful for diagnosing central auditory processing disorders.

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APPENDIX - I

TEST LISTS

Familarization items :-

ಮಂಚ (1) /mancha/

ಬೆಕ್ಕು (2) /bekku/

ತುಟಿ (4) /tuti/

Test items :-

List-A

ಲೋಟ (4) /lo:ta/

ಏಣಿ (3) /e:ni/

ಚಾಕು (1) /cha:ku/

ಬಸ್ಸು (3) /bassu/

ಗೂಬೆ (2) /gu:be/

ಕತ್ತು (1) /kattu/

ಲಾರಿ (4) /la:ri/

ಮನೆ (1) /mane/

ನಲ್ಲಿ (3) /nalli/

ಮೇಕೆ (1) /me;ke/

ಮೊಲ (2) /mola/

ಕಾಗೆ (2) /ka;ge/

ಸೇಬು (4) /se:bu|

ಬೀಗ (1) /bi:ga/

ಕೋಳಿ (1) /ko:li/

ಹೂವು (3) /hu:vu/

ಮೂಗು (1) /mu:gu/

ಹಸು (1) /hasu/

ಮಳೆ (3) /male/

ಕಪ್ಪೆ (2) /kappe/

ಕಣ್ಣು (1) /kannu/

List-B

ಕಣ್ಣು (1) /kannu/

ಹೂವು (4) /hu:vu/

ಕಾಗೆ (4) /ka:ge/

ಕಪ್ಪೆ (2) /kappe/

ಮೊಲ (3) /mola/

ಏಣಿ (4) /e:ni/

ಮಳೆ (2) /male/

ಲೋಟ (4) /lo:ta/

ದಾರ (1) /da:ra/

ಚಾಕು (2) /cha:ku/

ಮನೆ (3) /mane/

ನಲ್ಲಿ (4) /nalli/

ಓಲೆ (2) /o:le/

ಬಸ್ಸು (2) /bassu/

ಕತ್ತು (3) /kattu/

ಗೂಬೆ (2) /gu:be/

ಛತ್ರಿ (4) /chatri/

ಮೇಕೆ (4) /me;ke/

ಸೇಬು (1) /se:bu/

ಬೀಗ (4) /bi:ga/

ಲಾರಿ (3) /la:ri/

ದಾರ (1) /ḍa:ra/

ಛತ್ರಿ (4) /chaṭri/

ಚೀಲ (1) /chi:la/

ಮೀನು (1) /mi:nu/

ಮೇಜು (2) /me:ju/

ಇಲಿ (4) /ili/

ಸೂಜಿ (3) /su:ji/

ತಲೆ (4) /ṭale/

ಕಿವಿ (2) /kivi/

ಪೆನ್ನು (3) /pennu/

ಮರ (4) /mara/

ಬಳೆ (1) /bale/

ಕಾಲು (2) /ka:lu/

ಗಂಟೆ (3) /gaṇte/

ಸರ (4) /sara/

ಚೆಂಡು (2) /chendu/

ರೈಲು (1) /railu/

ಕಾರು (4) /ka:ru/

ಓಲೆ (2) /o:le/

ಆನೆ (2) /a:ne/

ತಟ್ಟೆ (4) /ṭatte/

ಗಿಣಿ (3) /gini/

ಹಾವು (1) /ha:vu/

ನಾಯಿ (3) /na:yi/

ಹಲ್ಲು (1) /hallu/

ಕಾಸು (2) /ka:su/

ಸೂರ್ಯ (4) /su:rya/

ನೀರು (1) /ni:ru/

ಎಲೆ (3) /ele/

ಮೂಗು (4) /mu:gu/

ಕಾಗೆ (2) /ka:ge/

ಗಿಣಿ (3) /gini/

ತಟ್ಟೆ (2) /ṭatte/

ಸರ (4) /sara/

ಕಾರು (3) /ka:ru/

ಪೆನ್ನು (3) /pennu/

ನೀರು (2) /ni:ru/

ಬಳೆ (4) /bale/

ಆನೆ (4) /a:ne/

ಚೆಂಡು (1) /chendu/

ಹಲ್ಲು (3) /hallu/

ಮರ (3) /mara/

ಮೀನು (1) /mi:nu/

ನಾಯಿ (3) /na:yi/

ಕೋಳಿ (3) /ko:ḷi/

ಕಿವಿ (3) /kivi/

ಇಲಿ (2) /ili/

ಸೂರ್ಯ (1) / su:ryaØ

ಕಾಸು (1) /ka:su/

ಕಾಲು (3) /ka:lu/

ಎಲೆ (1) /ele/

ಚೀಲ (3) /chi:la/

ಮೇಜು (2) /me:ju/

ಸೂಜಿ (3) /su:ji/

ಗಂಟೆ (1) /ganṭe/

ರೈಲು (1) /railu/

ತಲೆ (3) /ṭale/

ಹಾವು (1) /ha:vu/

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

APPENDIX-II

SCORE SHEET

Name : Age/Sex: Date:

Audiological findings

	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
R					
L					

Key : Correct Response ✓
Incorrect Response X

List-A

Level ______dB (w.r.t. FA)

Correct % __________

ಲೋಟ (4) /lo:ta/
ಏಣಿ (3) /e:ni/
ಚಾಕು (1) /cha:ku/
ಬಸ್ಸು (3) /bassu/
ಗೂಬೆ (2) /gu:be/
ಕತ್ತು (1) /kat̪t̪u/
ಲಾರಿ (4) /la:ri/
ಮನೆ (1) /mane/
ನಲ್ಲಿ (3) /nalli/
ಮೇಕೆ (1) /me:ke/
ಮೊಲ (2) /mola/
ಕಾಗೆ (2) /ka:ge/
ಸೇಬು (4) /se:bu/
ಬೀಗ (1) /bi:ga/

List-B

Level________dB (w.r.t.FA)

Correct % __________

ಕಣ್ಣು (1) /kaṇṇu/
ಹೂವು (4) /hu:vu/
ಕಾಗೆ (4) /ka:ge/
ಕಪ್ಪೆ (2) /kappe/
ಮೊಲ (3) /mola/
ಏಣಿ (4) /e:ni/
ಮಳೆ (2) /male/
ಲೋಟ (4) /lo:ta/
ದಾರ (1) /d̪a:ra/
ಚಾಕು (1) /cha:ku/
ಮನೆ (3) /mane/
ನಲ್ಲಿ (4) /nalli/
ಓಲೆ (2) /o:le/
ಬಸ್ಸು (2) /bassu/

ಕೋಳಿ (1) /ko:ḷi/

ಹೂವು (3) /hu:vu/

ಮೂಗು (1) /mu:gu/

ಹಸು (1) /hasu/

ಮಳೆ (3) /male/

ಕಪ್ಪೆ (2) /kappe/

ಕಣ್ಣು (1) /kaṇṇu/

ದಾರ (1) /d̪a:ra/

ಛತ್ರಿ (4) /chat̪ri/

ಚೀಲ (1) /chi:la/

ಮೀನು (1) /mi:nu/

ಮೇಜು (2) /me:ju/

ಇಲಿ (4) /ili/

ಸೂಜಿ (3) /su:ji/

ತಲೆ (4) /t̪ale/

ಕಿವಿ (2) /kivi/

ಪೆನ್ನು (3) /pennu/

ಮರ (4) /mara/

ಬಳೆ (1) /bale/

ಕಾಲು (2) /ka:lu/

ಗಂಟೆ (3) /gante/

ಸರ (4) /sara/

ಚೆಂಡು (2) /chəndu/

ರೈಲು (1) /railu/

ಕಾರು (4) /ka;ru/

ಓಲೆ (2) /o:le/

ಆನೆ (2) /a:ne/

ತಟ್ಟೆ (4) /t̪atte/

ಗಿಣಿ (3) /giṇi/

ಕತ್ತು (3) /kat̪t̪u/

ಗೂಬೆ (2) /gu:be/

ಛತ್ರಿ (4) /chat̪ri/

ಮೇಕೆ (4) /me:ke/

ಸೇಬು (1) /se:bu/

ಬೀಗ (4) /bi:ga/

ಲಾರಿ (3) /la:ri/

ಮೂಗು (4) /mu:gu/

ಕಾಗೆ (2) /ka:ge/

ಗಿಣಿ (3) /giṇi/

ತಟ್ಟೆ (2) /t̪atte/

ಸರ (4) /sara/

ಕಾರು (3) /ka:ru/

ಪೆನ್ನು (3) /pennu/

ನೀರು (2) /ni:ru/

ಬಳೆ (4) /bale/

ಆನೆ (4) /a:ne/

ಚೆಂಡು (1) /chendu/

ಹಲ್ಲು (3) /hallu/

ಮರ (3) /mara/

ಮೀನು (1) /mi:nu/

ನಾಯಿ (3) /na:yi/

ಕೋಳಿ (3) /ko:ḷi/

ಕಿವಿ (3) /kivi/

ಇಲಿ (2) /ili/

ಸೂರ್ಯ (1) /surya/

ಕಾಸು (1) /ka:su/

ಕಾಲು (3) /ka:lu/

ಎಲೆ (1) /ele/

ಹಾವು (1) /ha:vu/

ನಾಯಿ (3) /na:yi/

ಹಲ್ಲು (1) /hallu/

ಕಾಸು (2) /ka:su/

ಸೂರ್ಯ (4) /su:rya/

ನೀರು (1) /ni:ru/

ಎಲೆ (3) /ele/

ಚೀಲ (3) /chi:la/

ಮೇಜು (2) /me:ju/

ಸೂಜಿ (3) /su:ji/

ಗಂಟೆ (1) /gante/

ರೈಲು (1) /railu/

ತಲೆ (3) /tale/

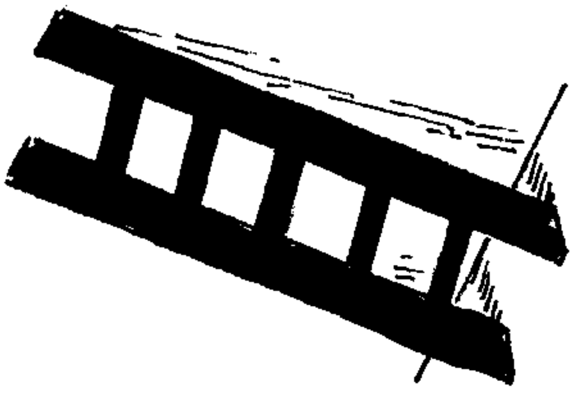
ಹಾವು (1) /ha:vu/

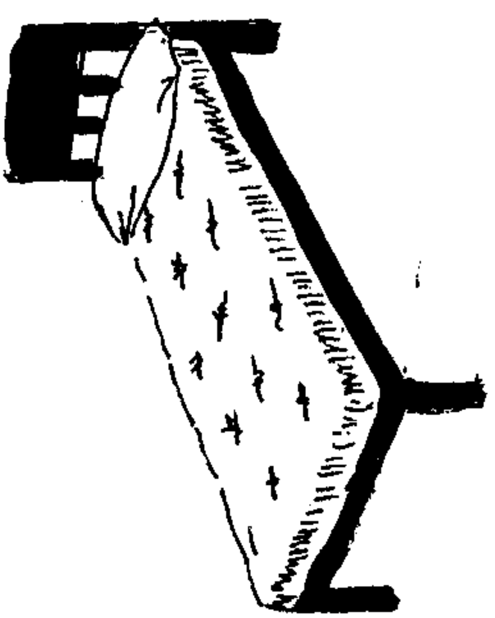
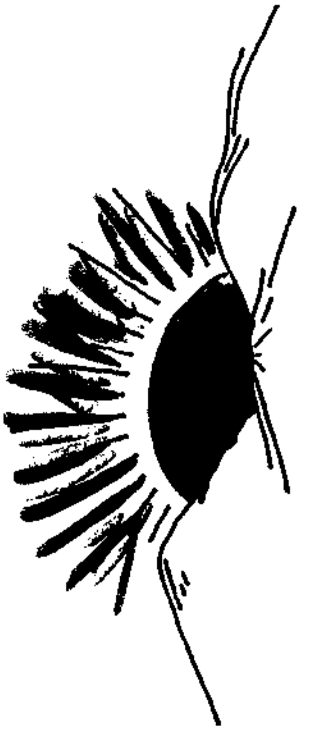
APPENDIX - 3.

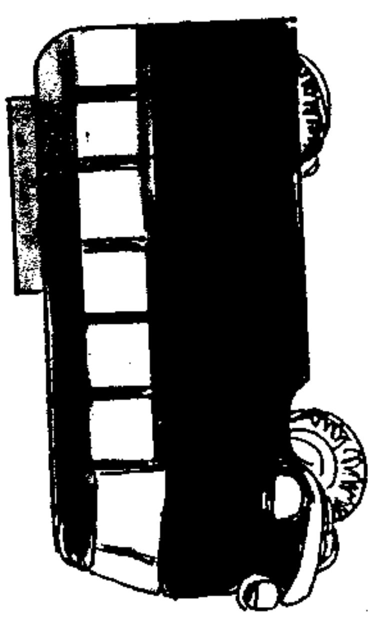
SPEECH IDENTIFICATION TEST FOR CHILDREN IN KANNADA

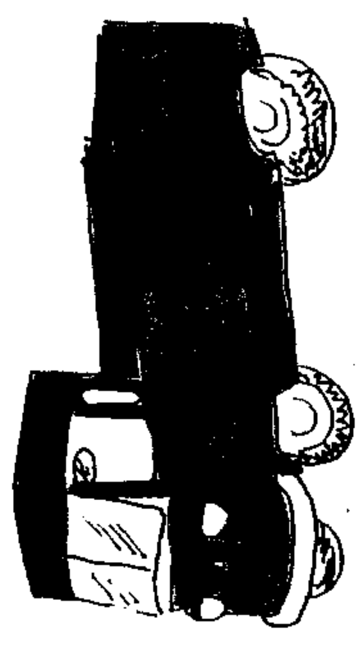
FAMILIARIZATION

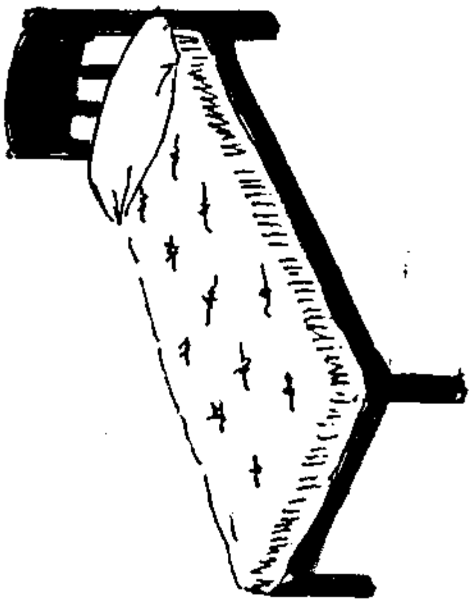
ITEMS

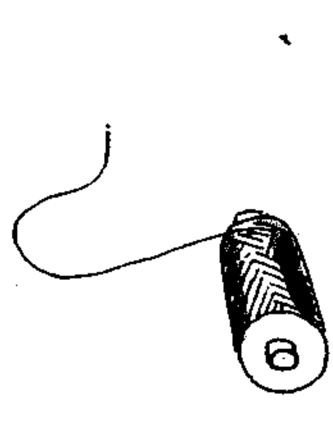


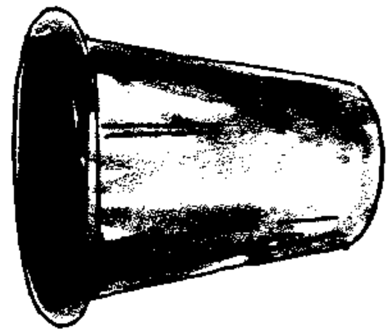


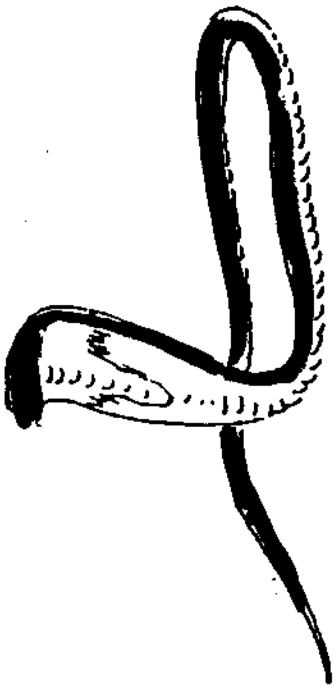


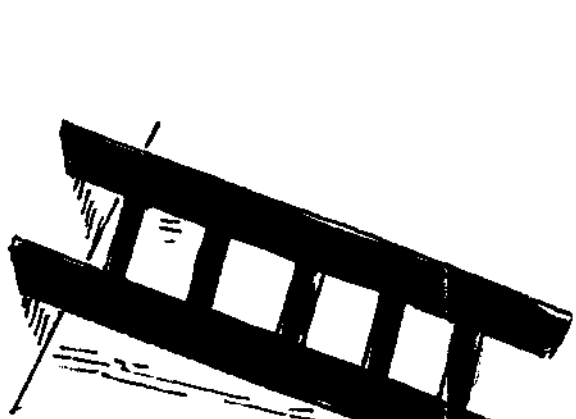


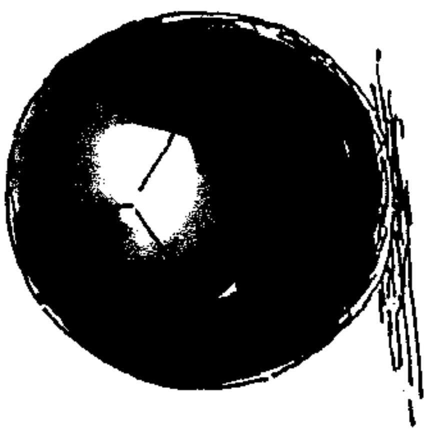


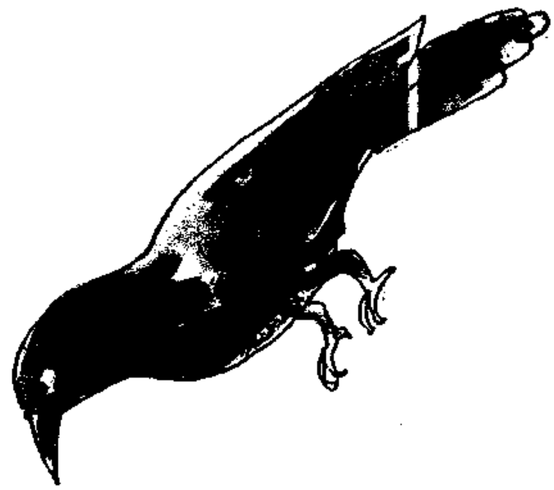
TEST ITEMS

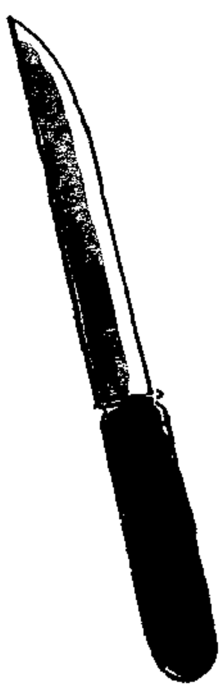


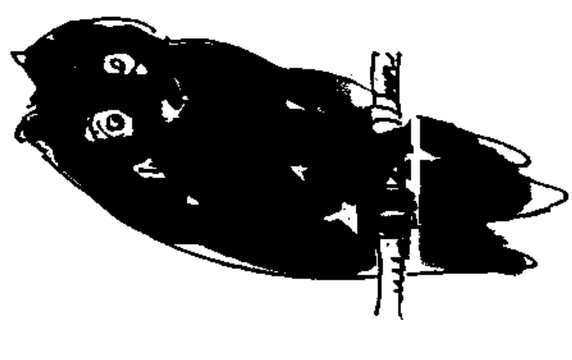


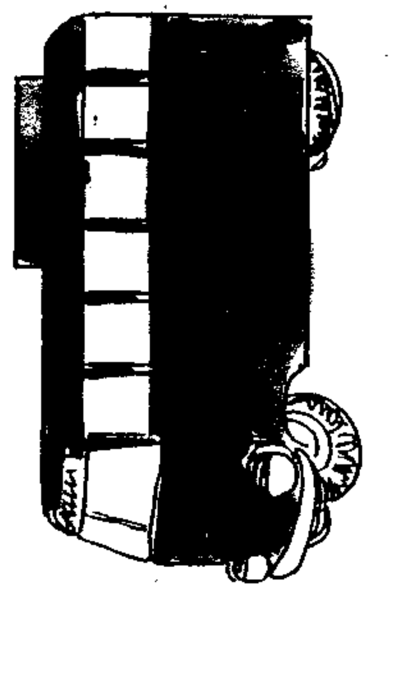


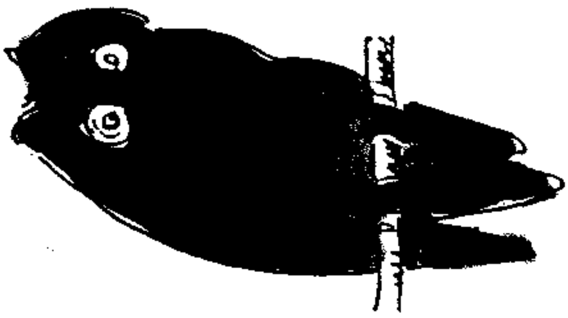


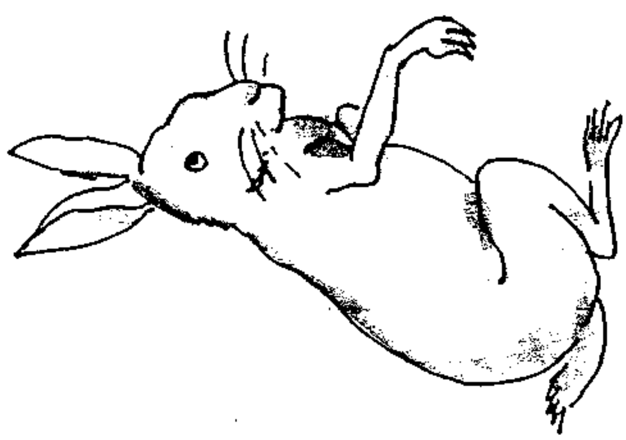


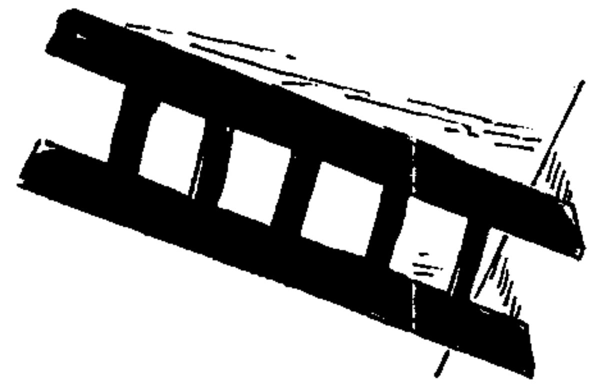


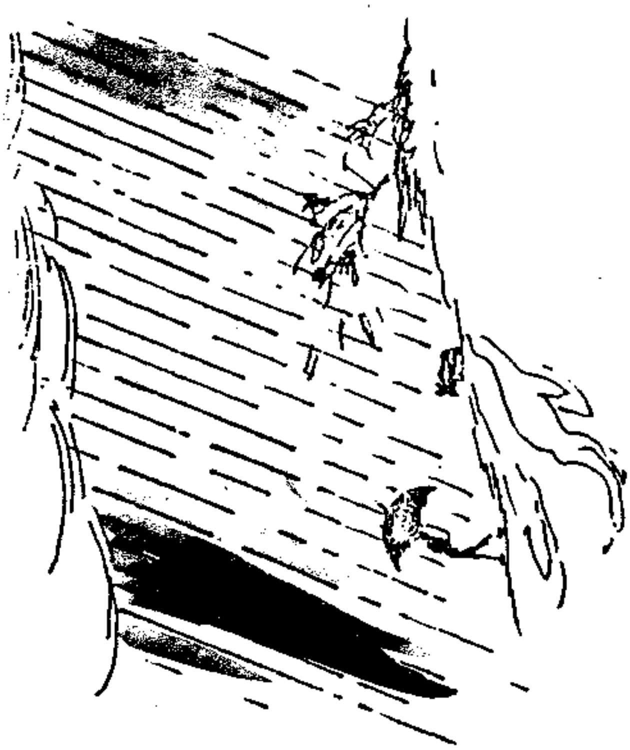
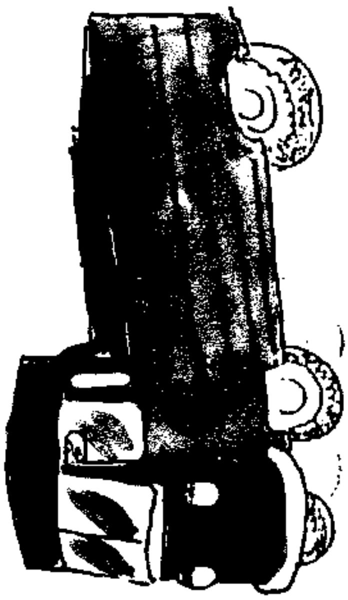
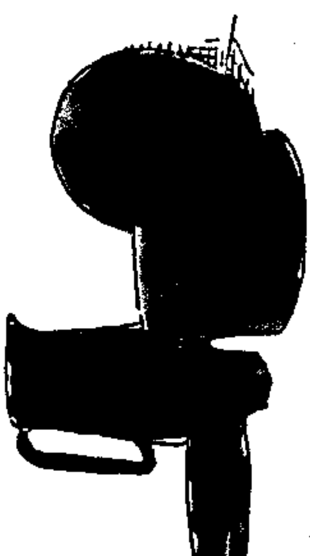


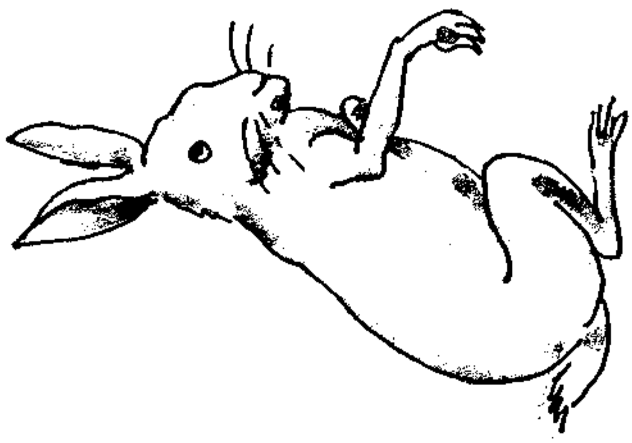
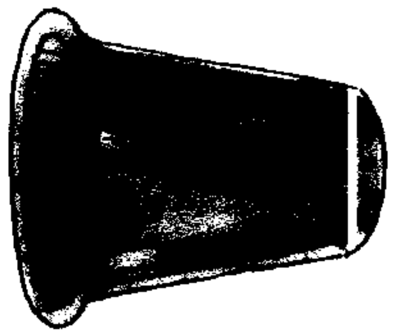
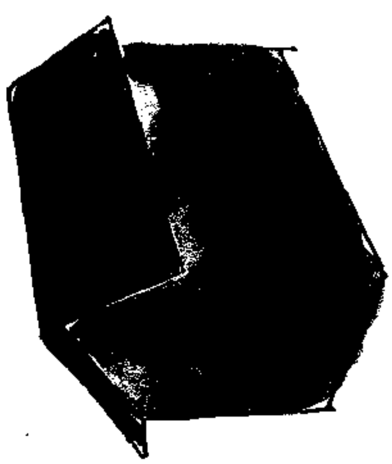
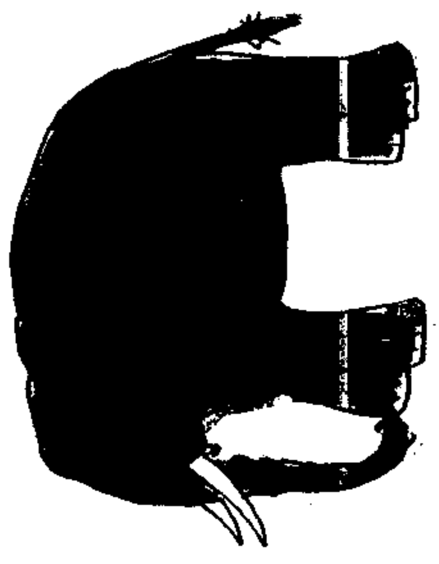


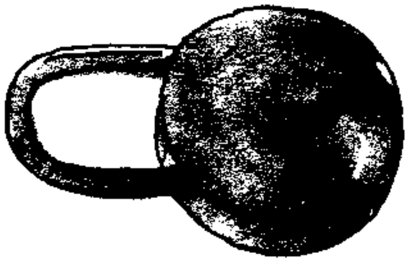


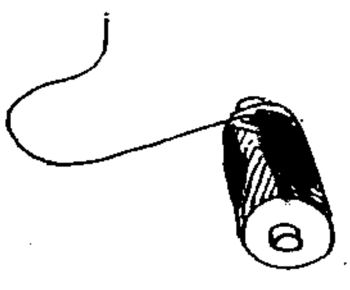


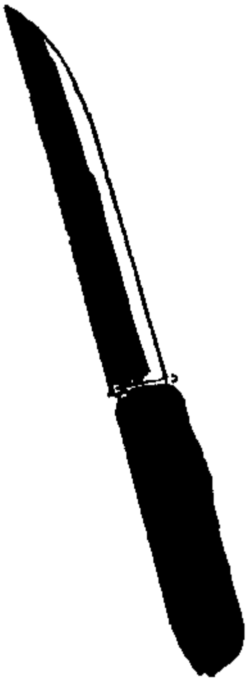
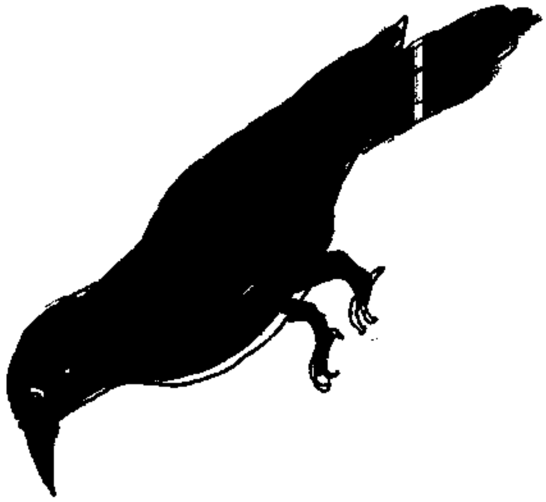



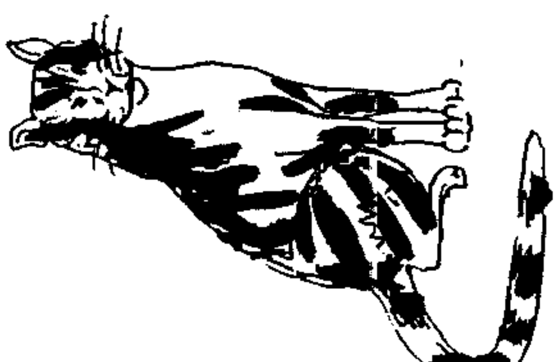




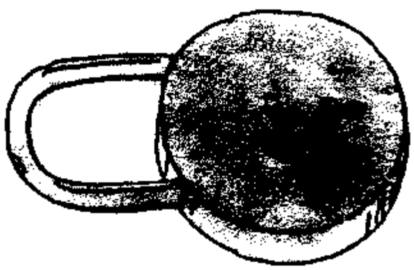






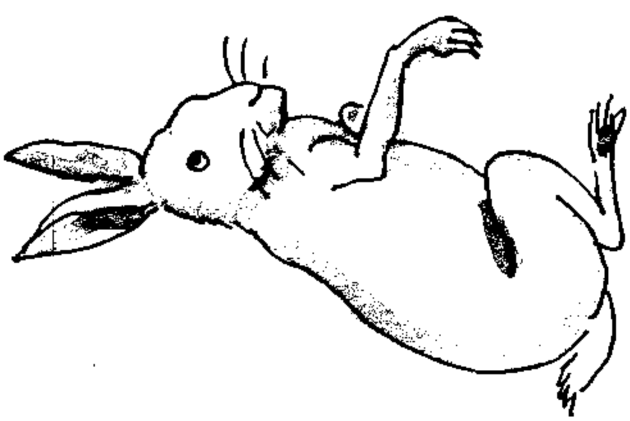


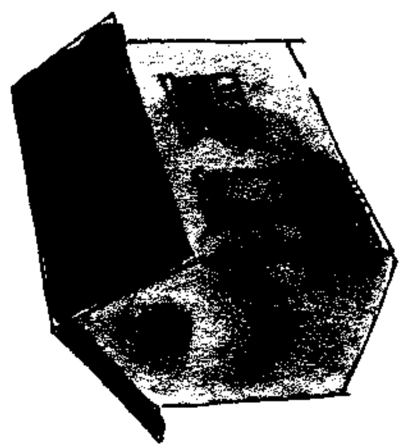


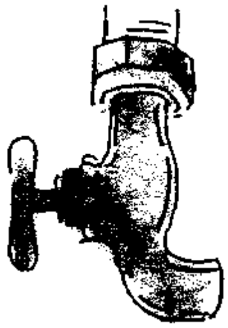



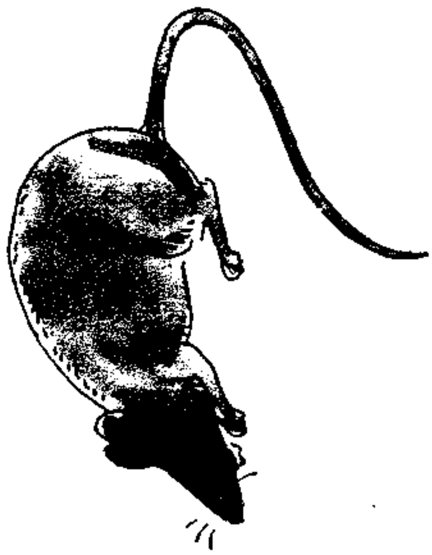


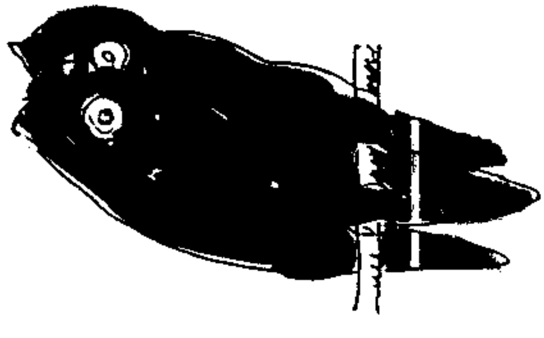


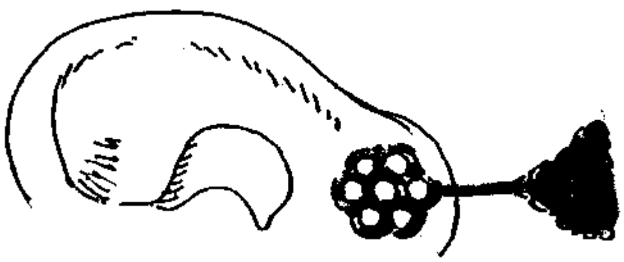
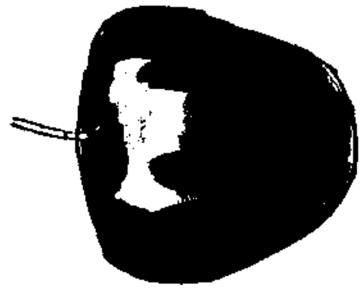
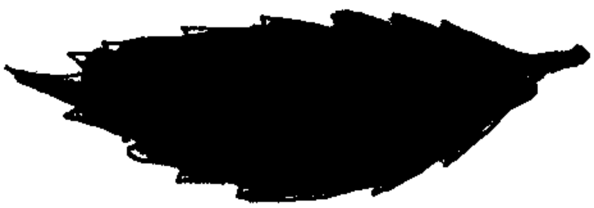


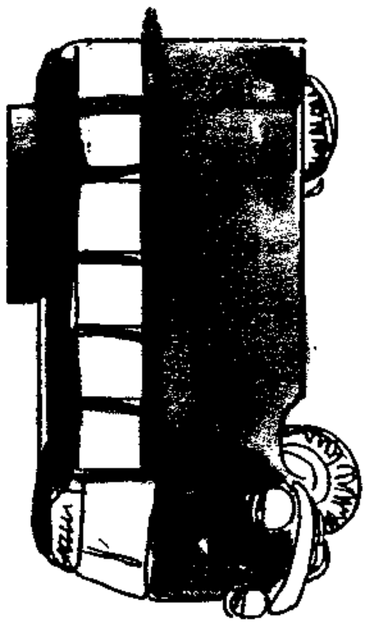
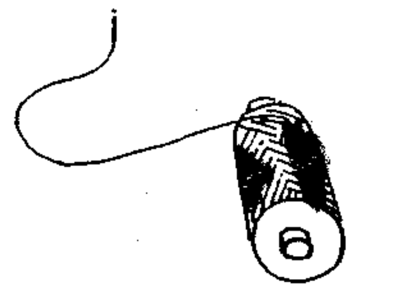
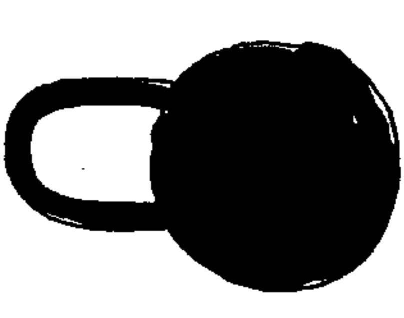


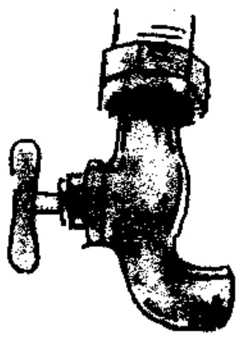


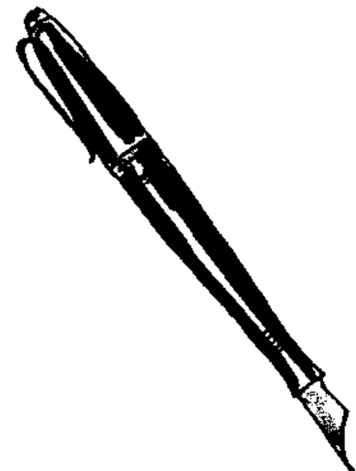


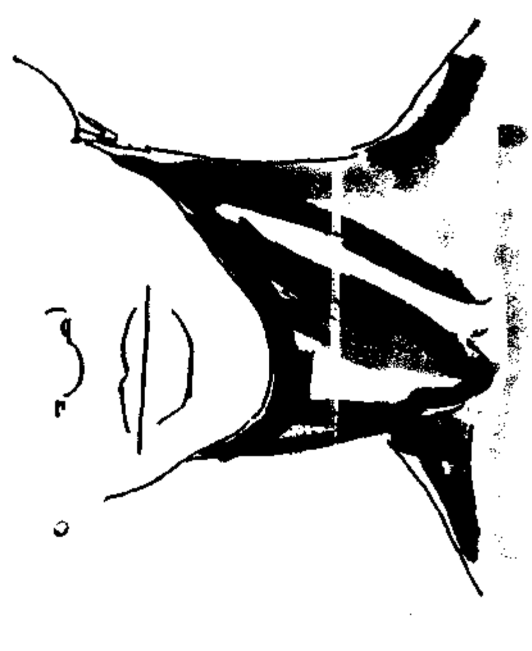


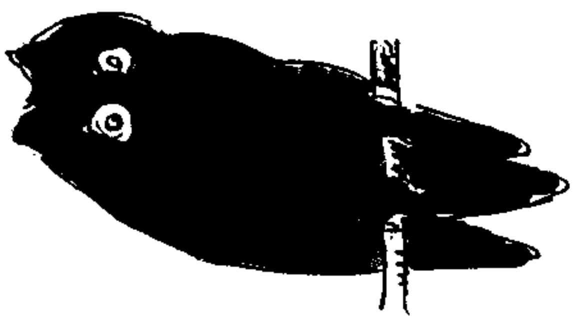




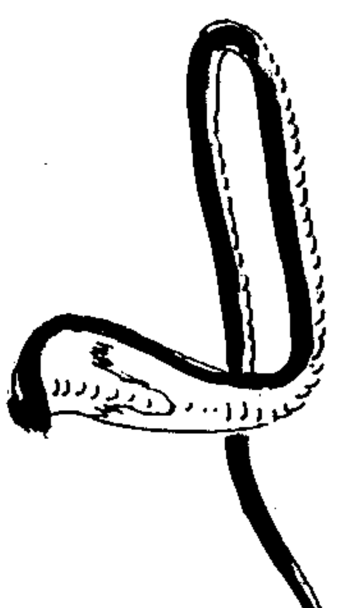





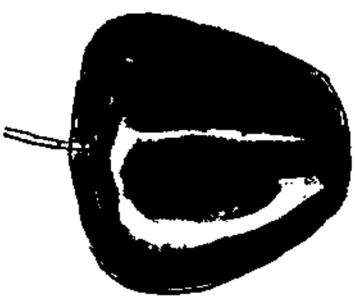



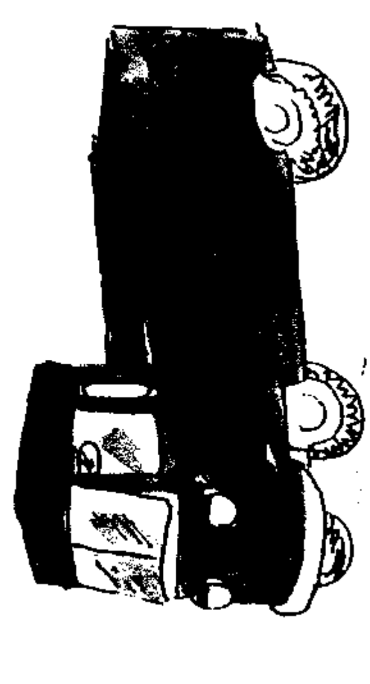


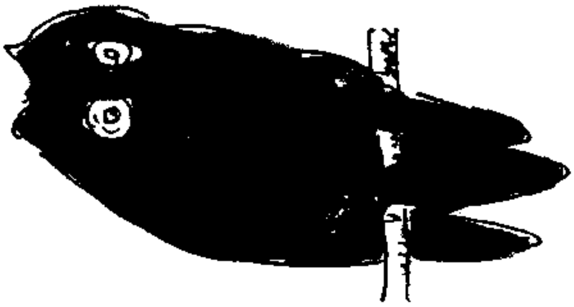


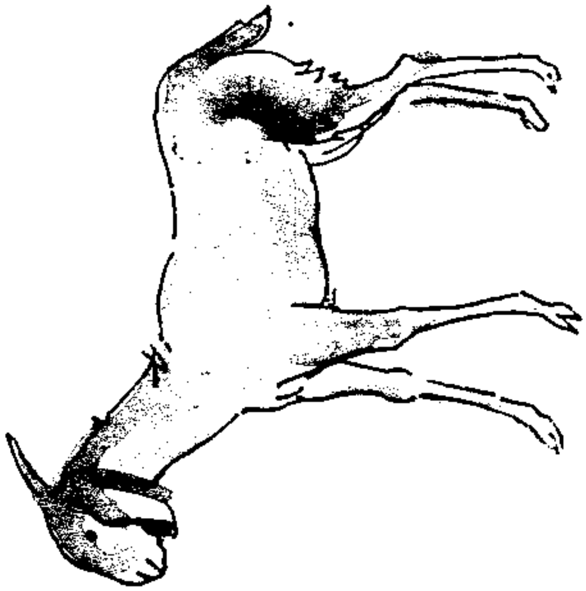


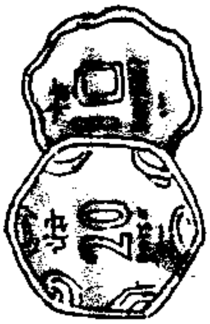


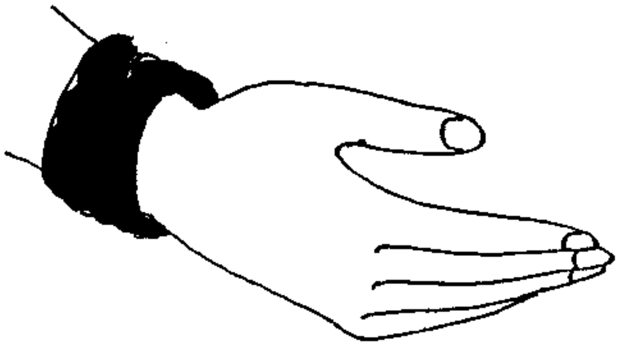


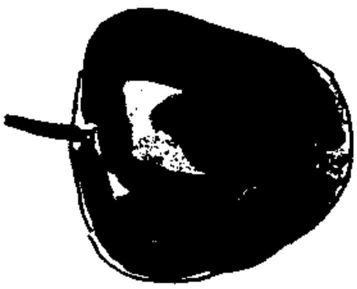


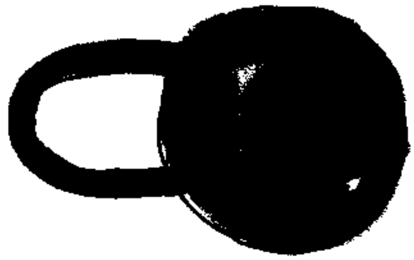


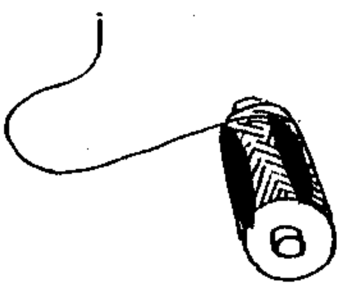


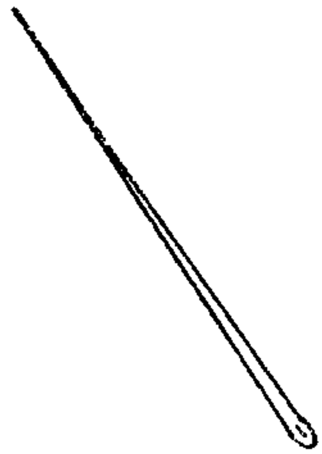


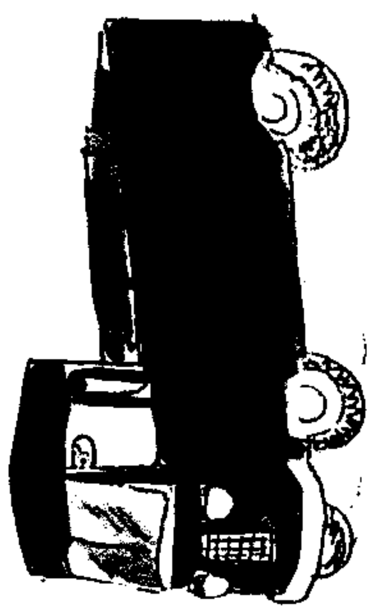


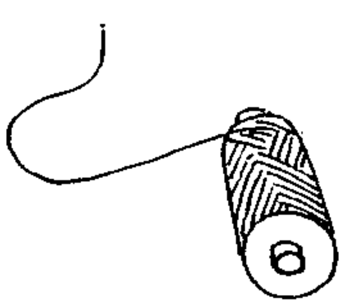


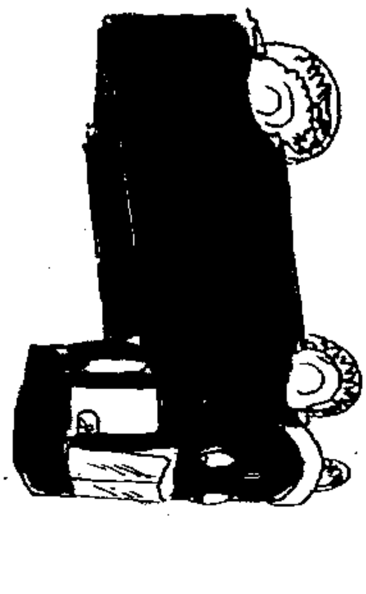
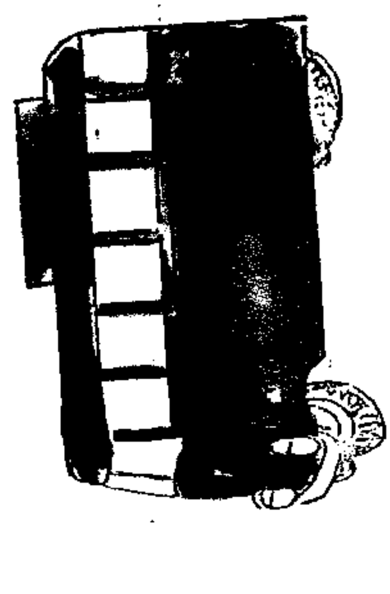


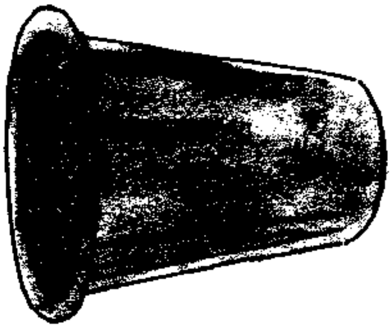


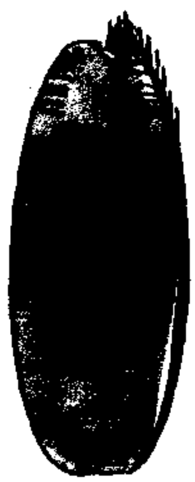
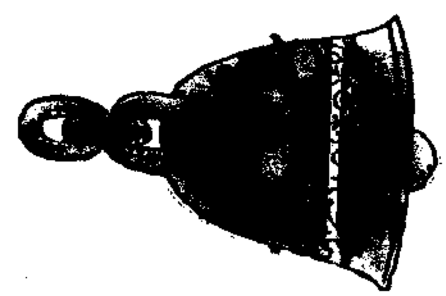


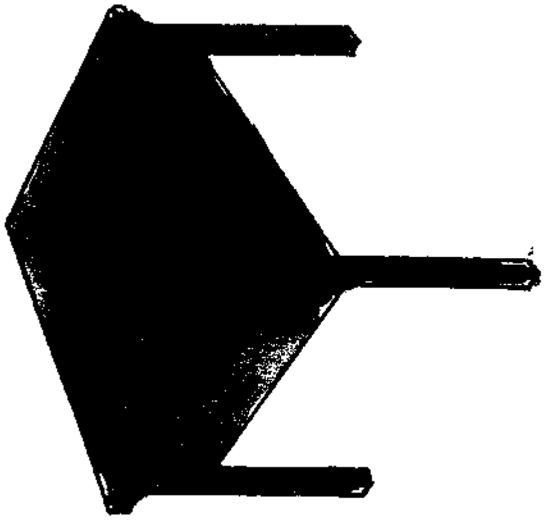


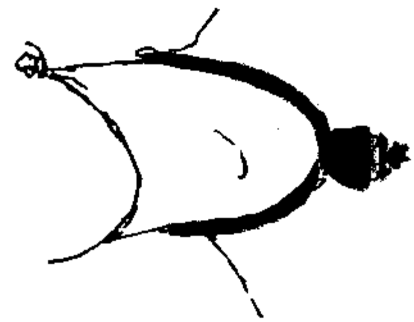


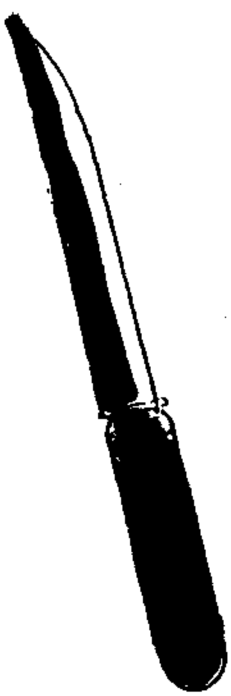



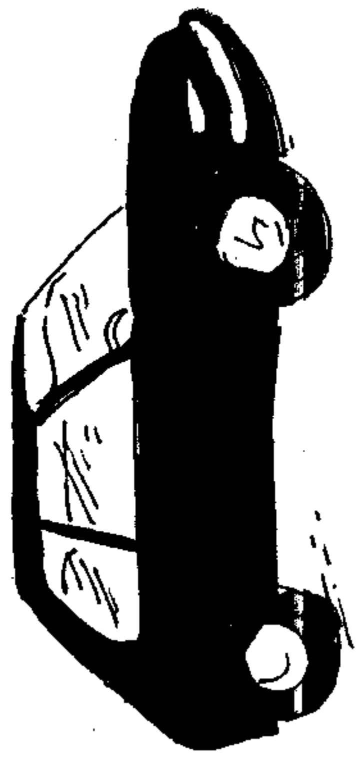


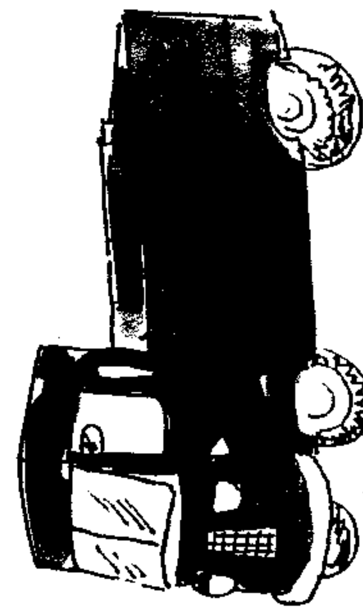




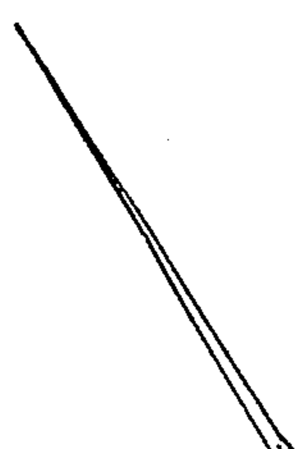


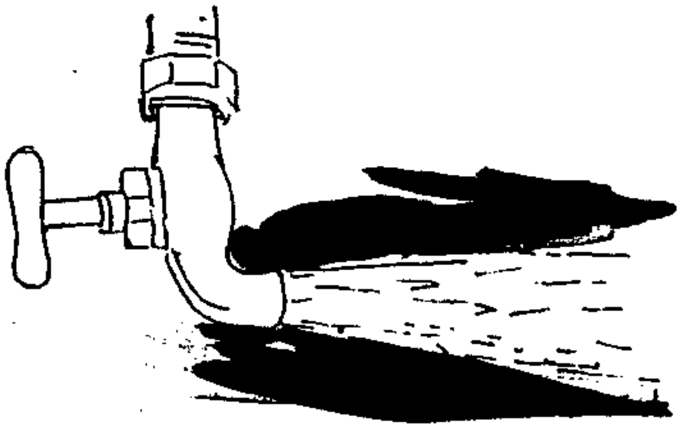


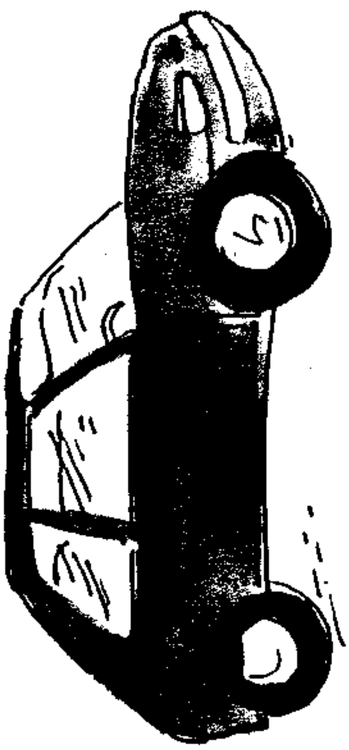


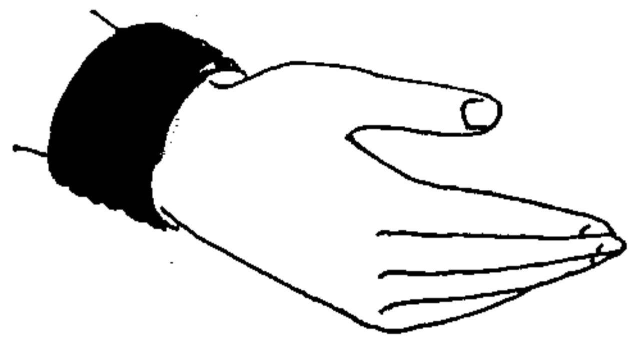


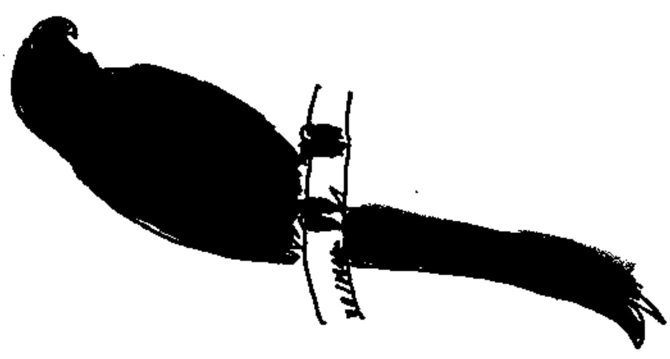


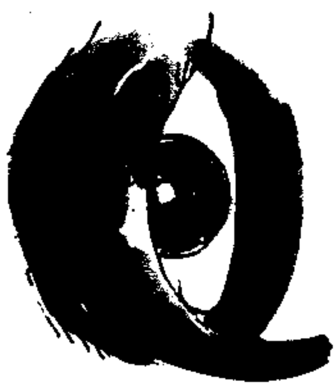


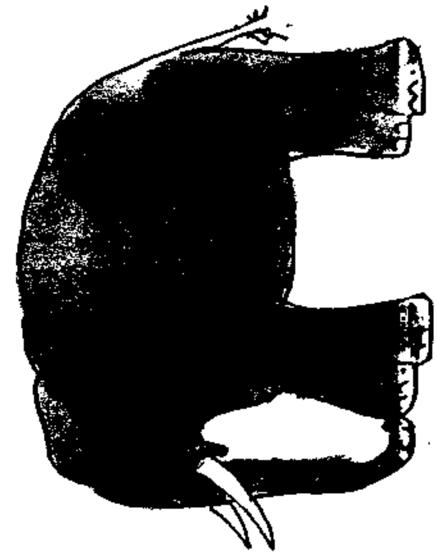


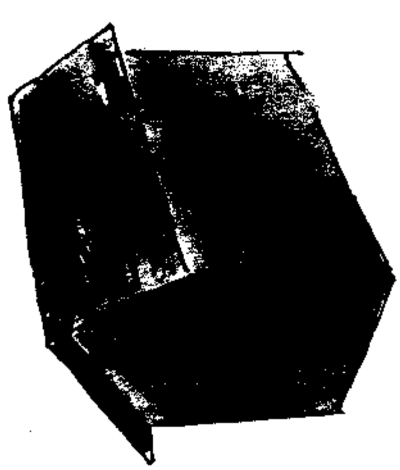




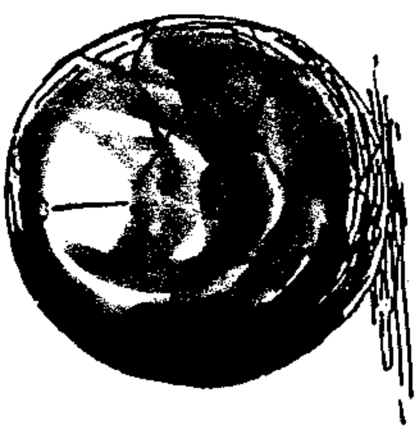
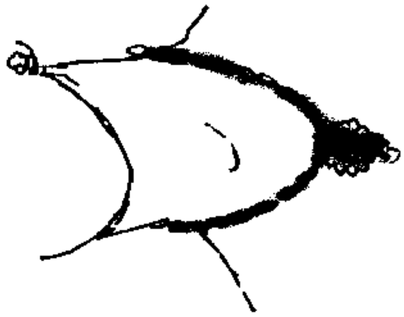


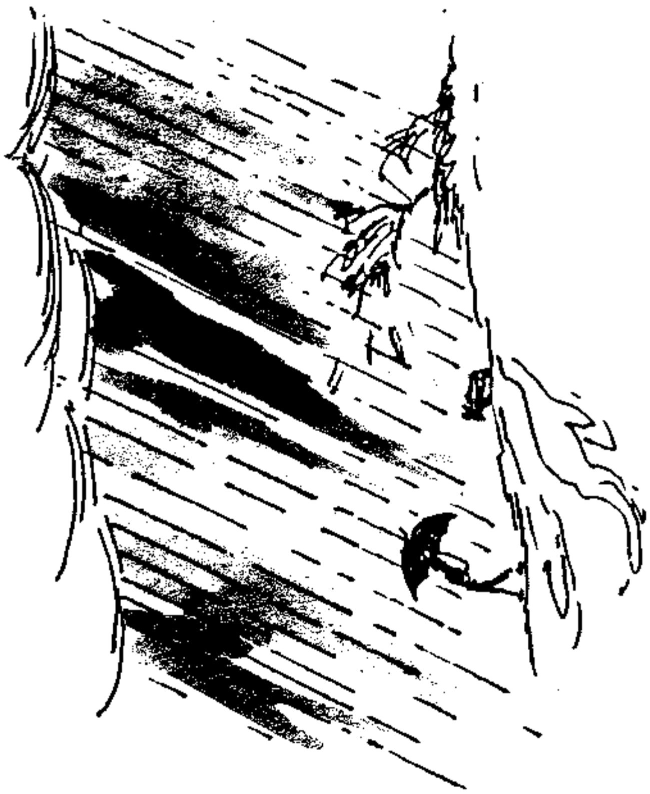


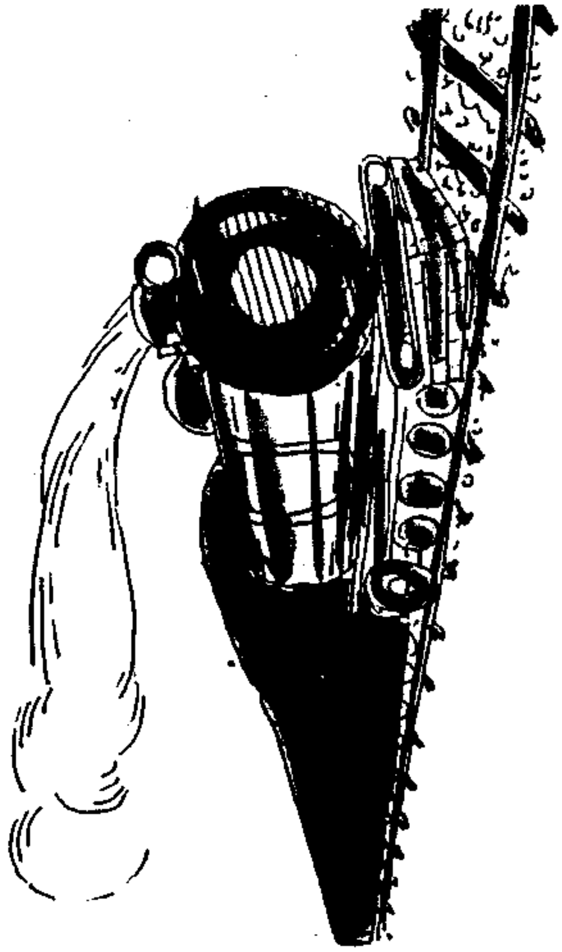


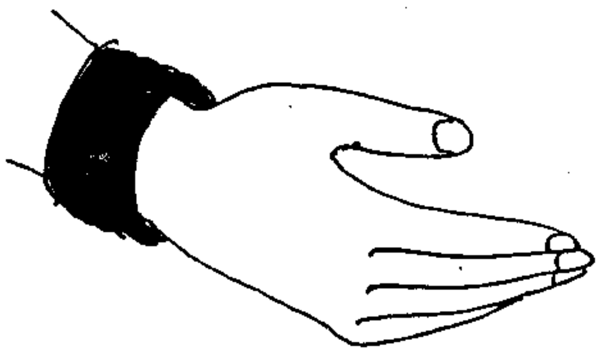


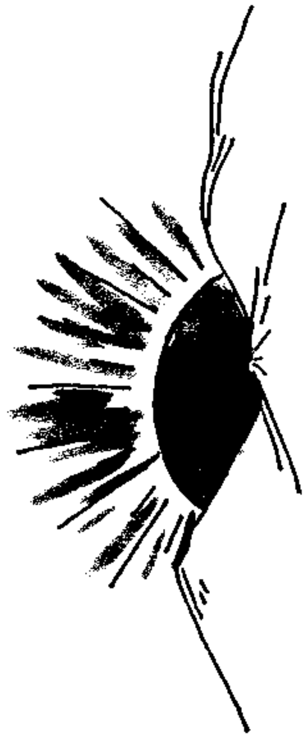


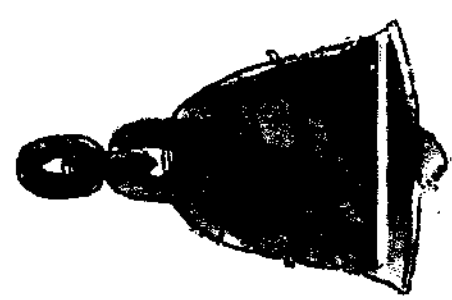



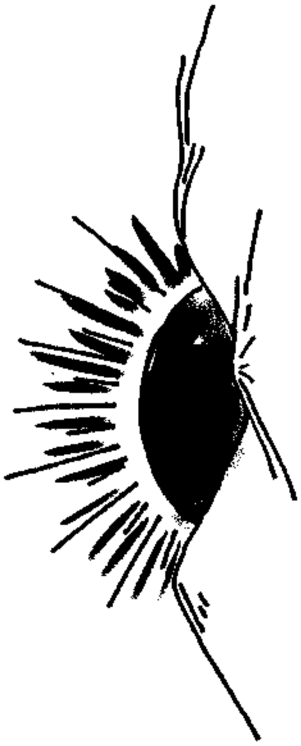


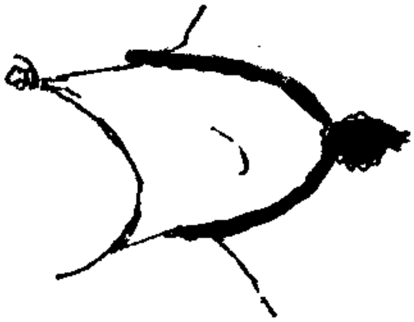


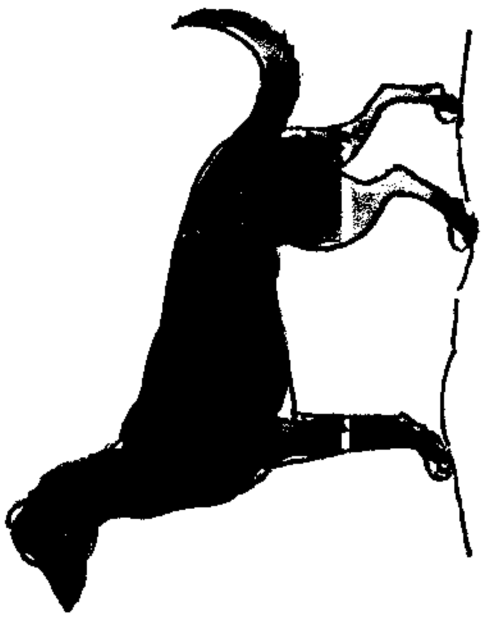


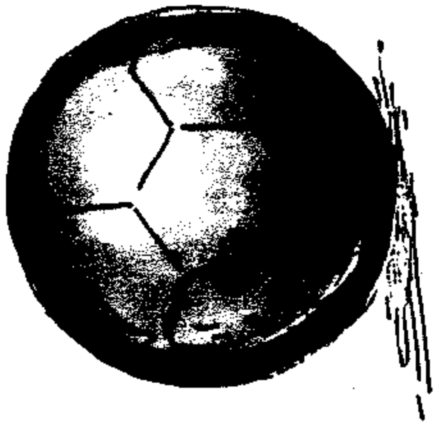


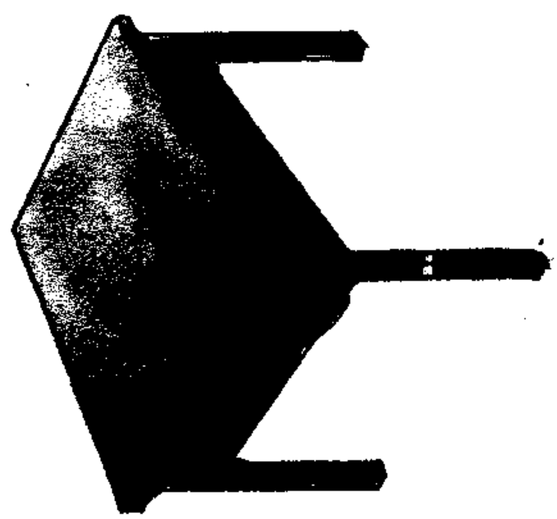


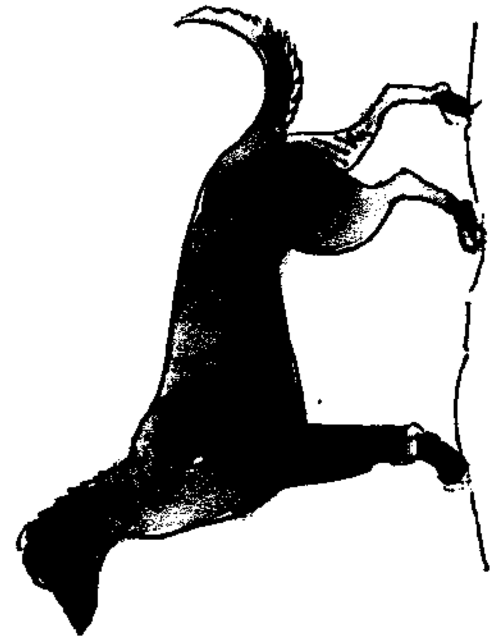


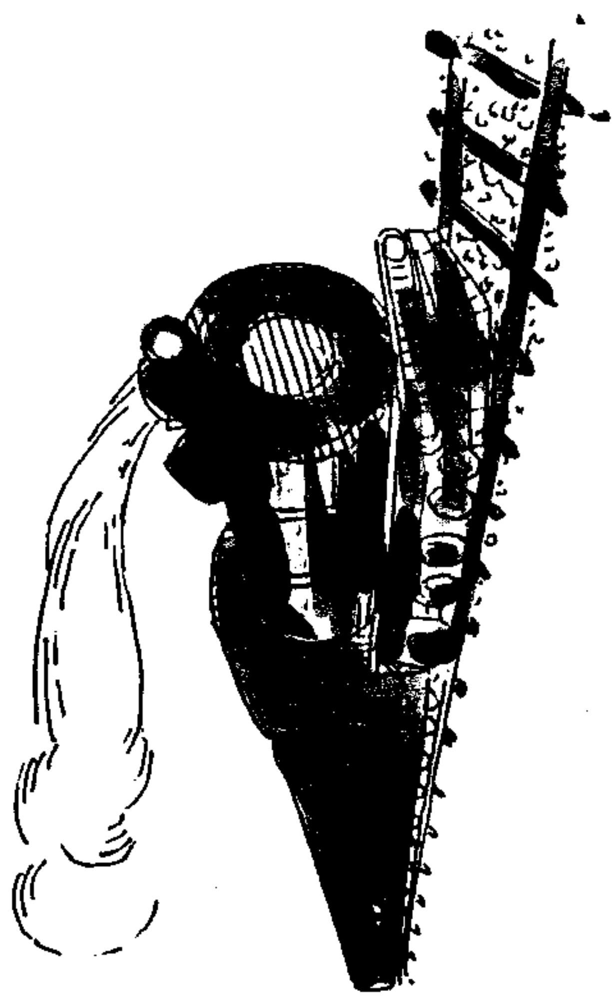


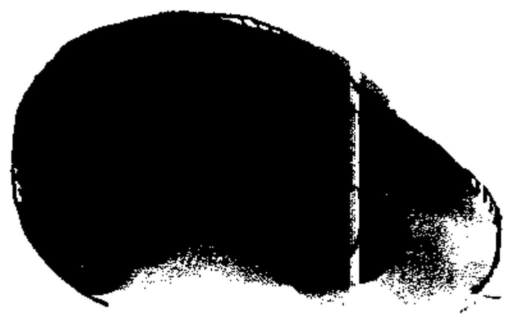


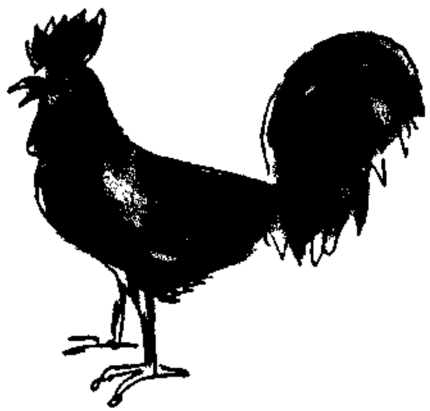


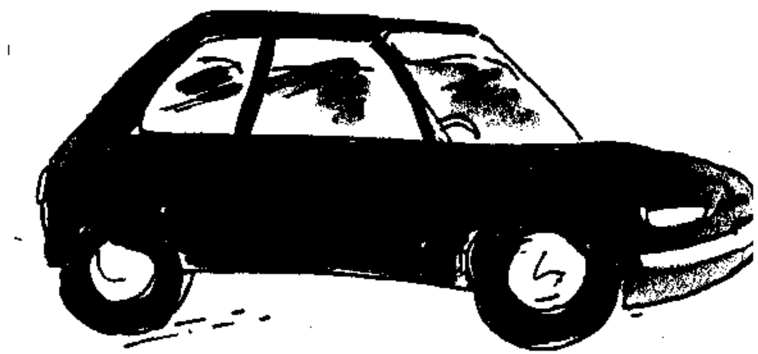


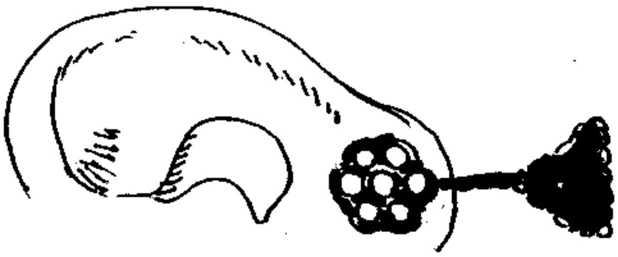


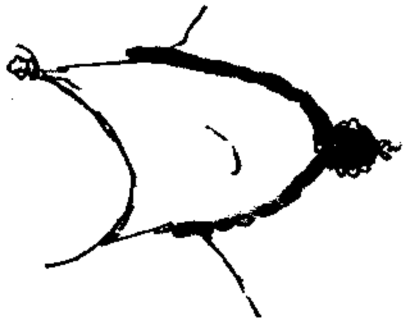


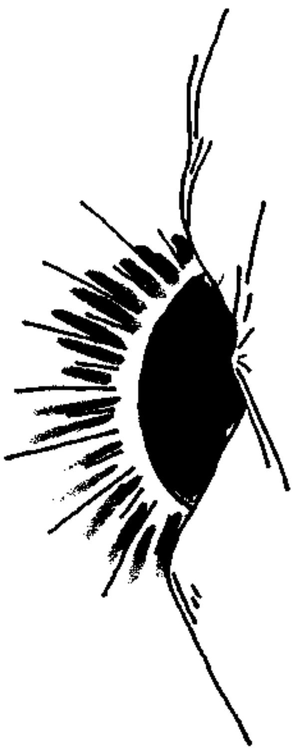


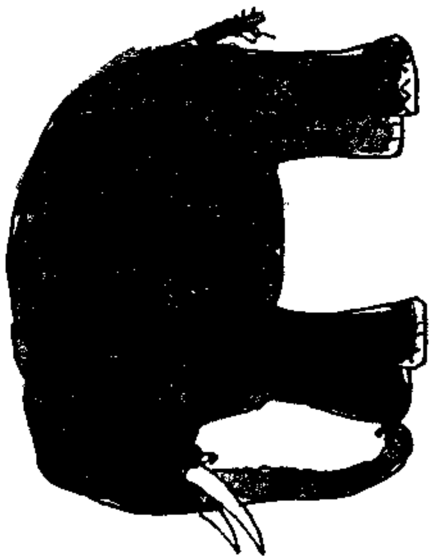


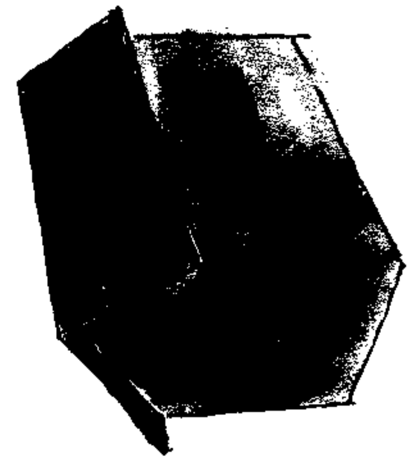


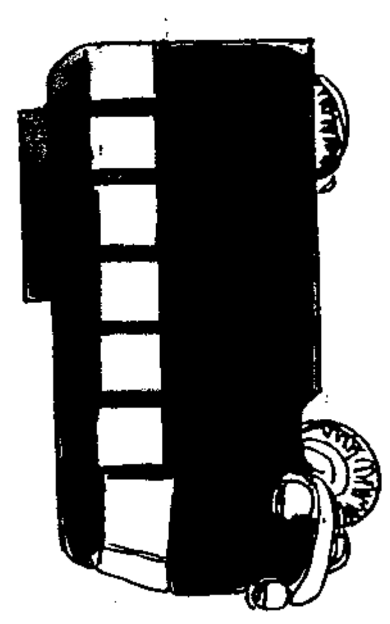


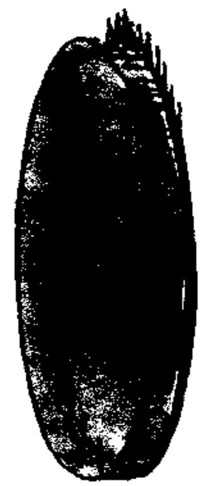


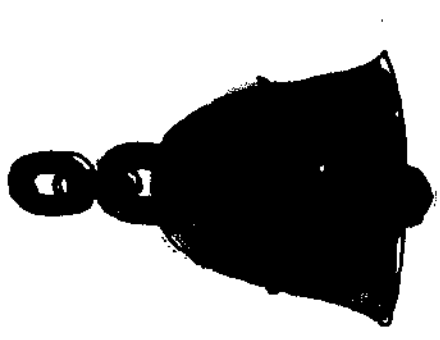


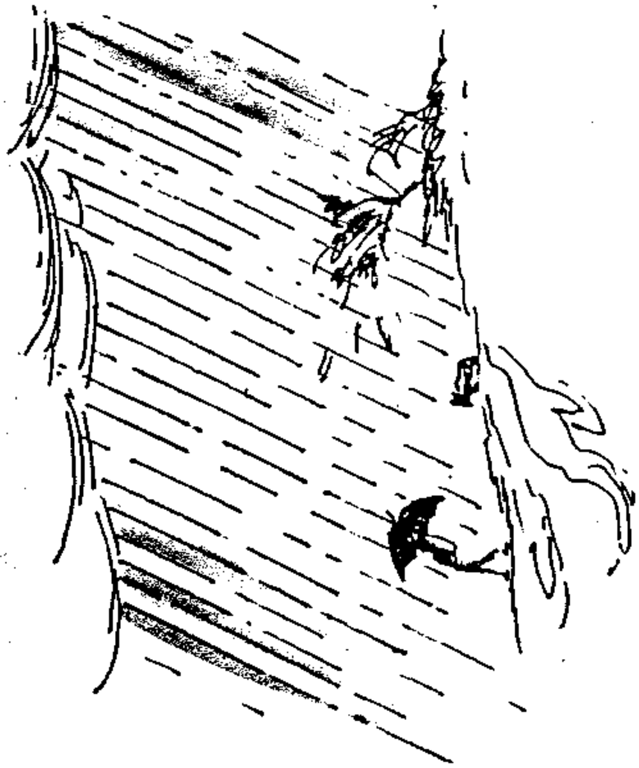


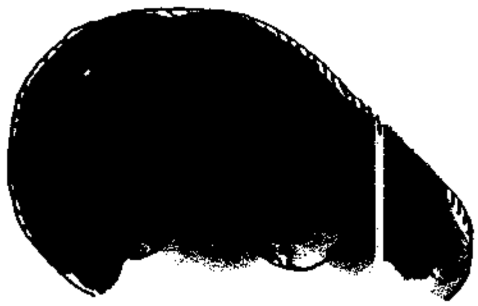


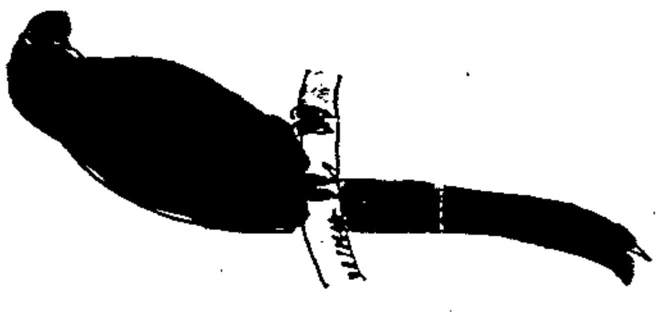


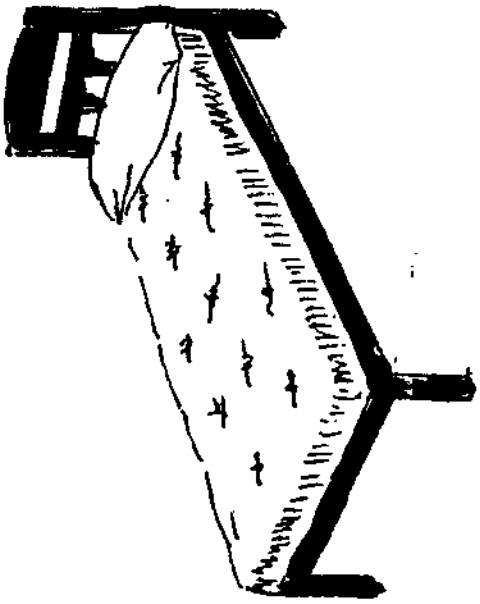
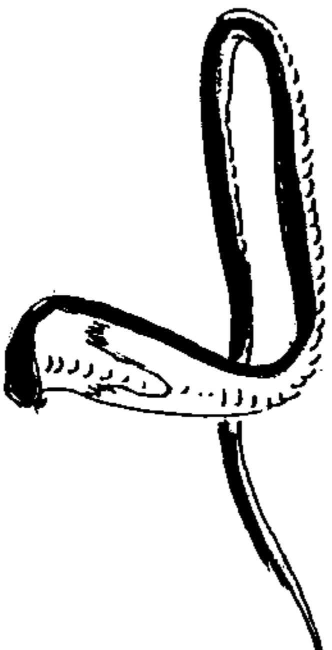


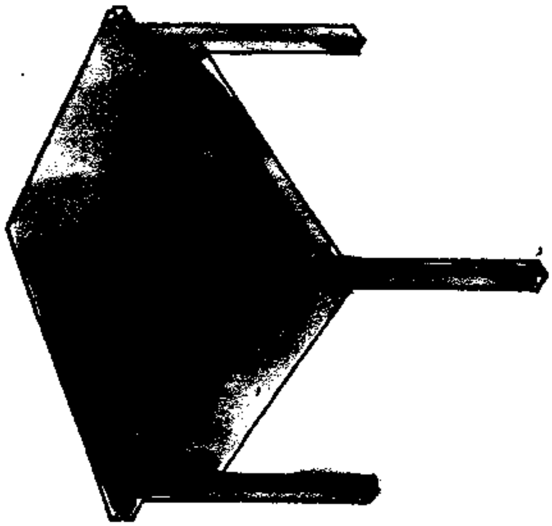


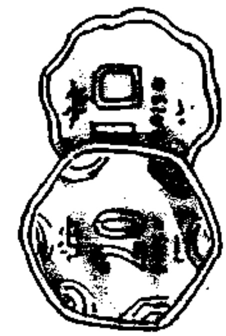


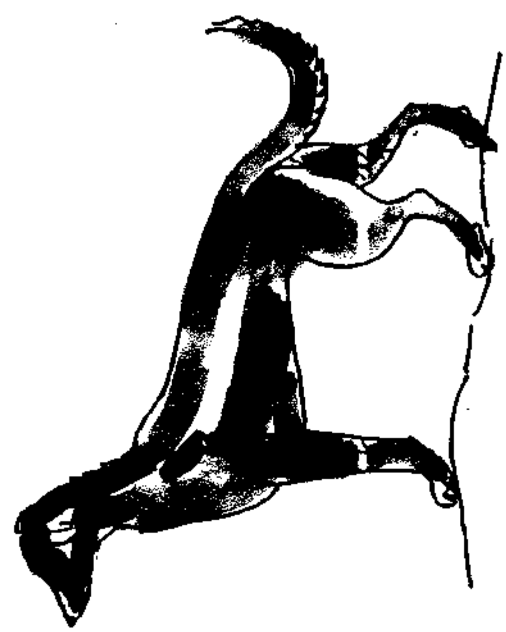


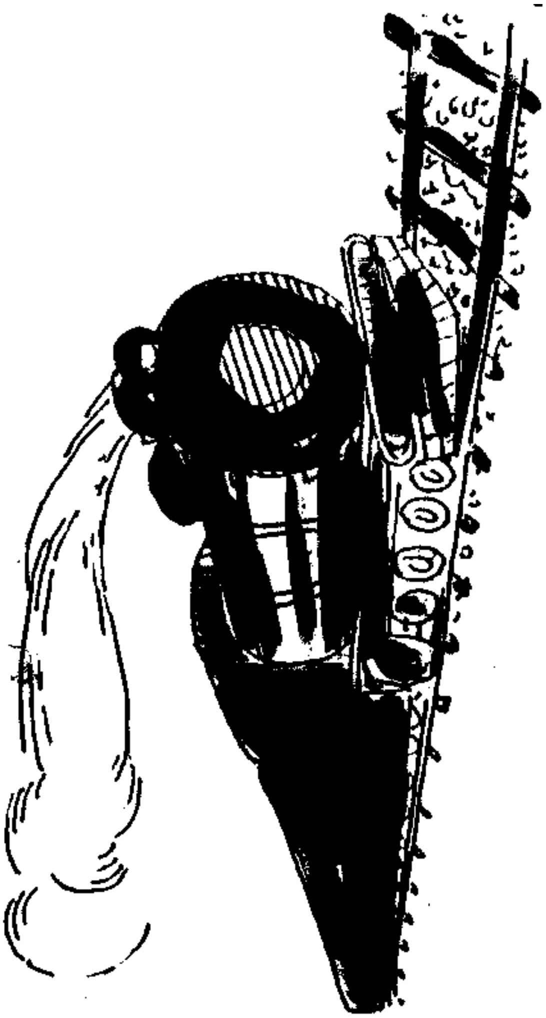


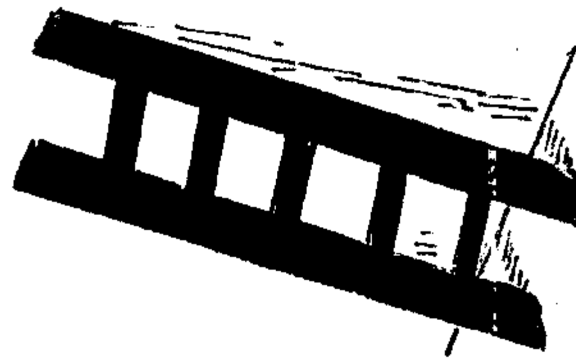




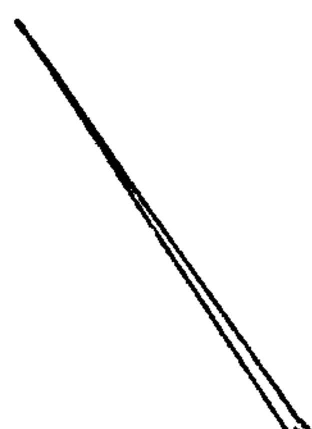



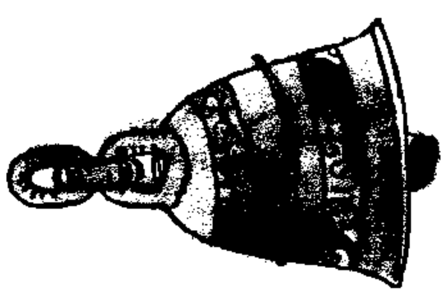


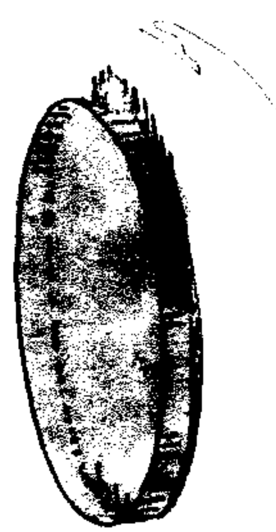


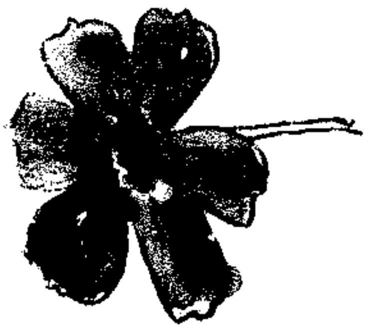


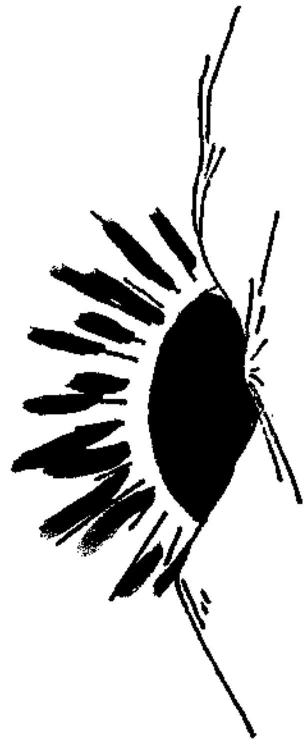


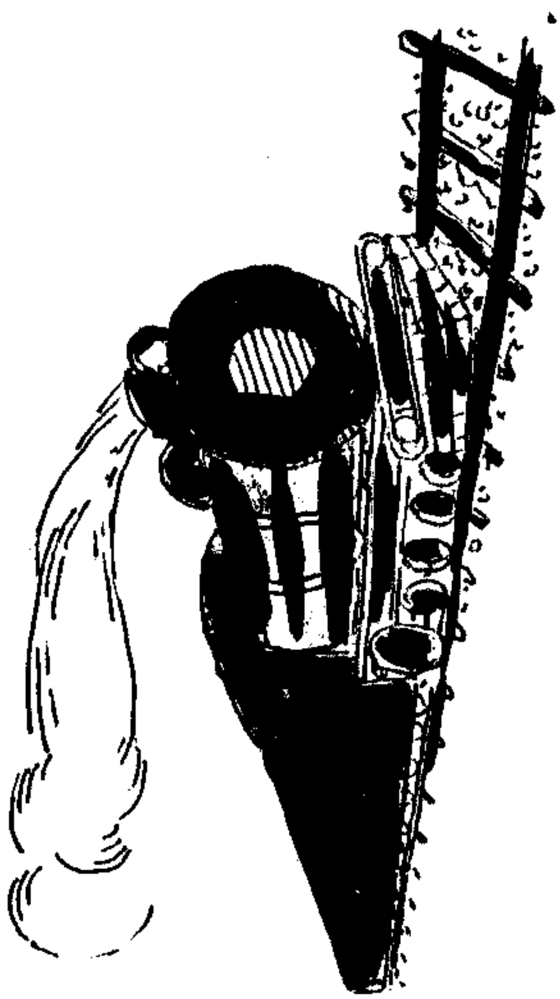


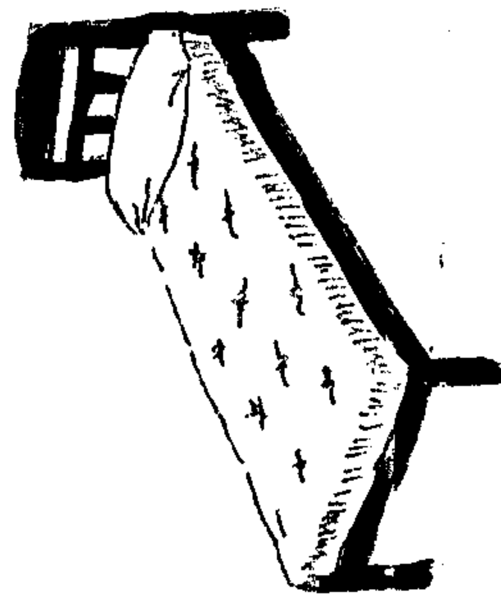


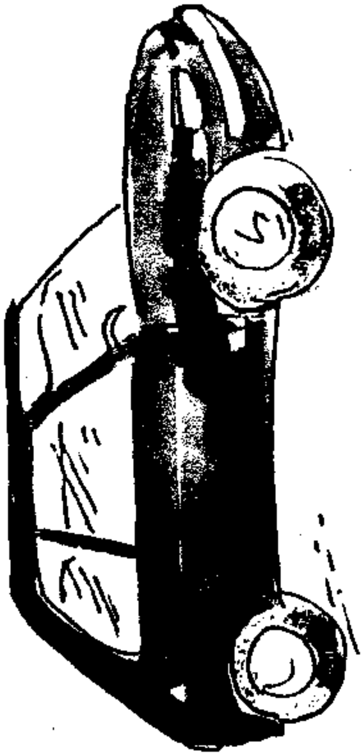


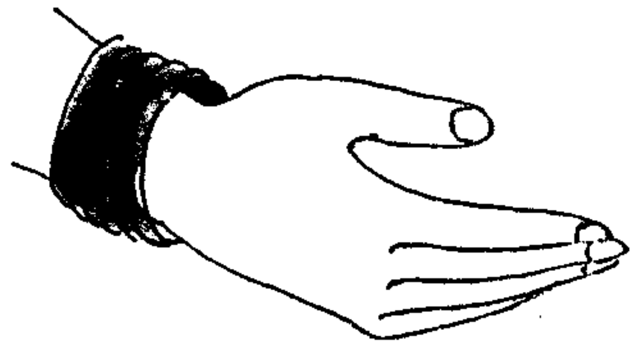


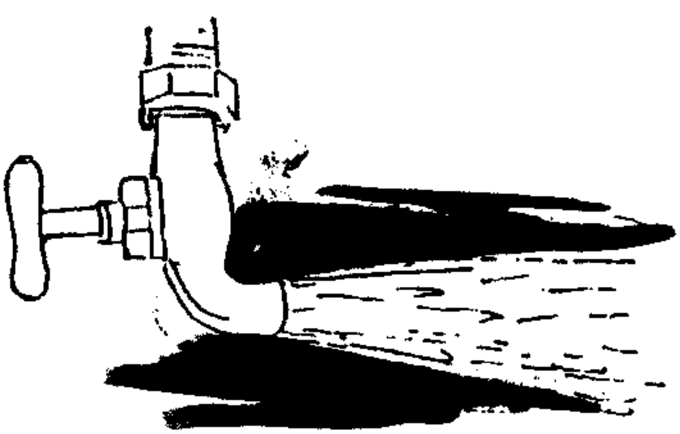


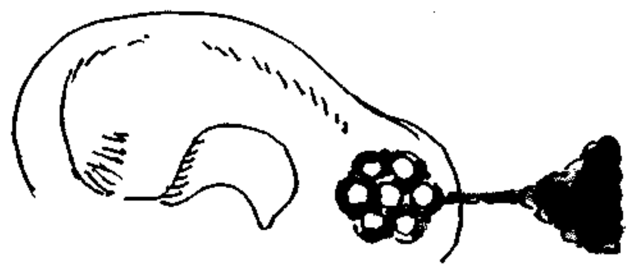


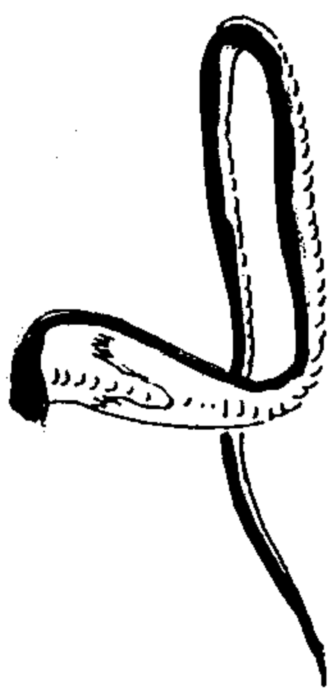
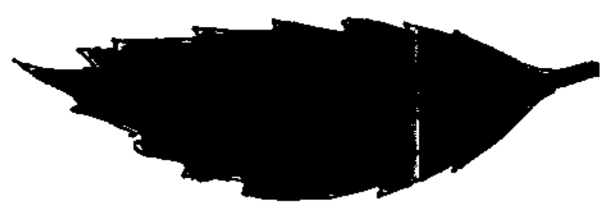










APPENDIX - IV

CALIBRATION PROCEDURE

Earphone Calibration :

Both intensity and frequency calibration was done for the pure tones generated by the clinical audiometer (Madsen OB 822).

Intensity Calibration :

Intensity calibration for air-conducted tones were carried out with the output of the audiometer set at 70 dBSL (ANSI, 1989). Through the earphones (THD 39 with MX-41/AR ear cushions) the acoustic output of the audiometer was given to a condenser microphone (B and K 4144) which was fitted into an artificial ear (B and K 4152). The signal was then fed to a sound level meter (B and K 2209) attached to an octave filter set (B and K 1613) through a pre-amplifier (B and K 2616). The sound level meter was fitted with a half inch to one inch adapter (B and K DB 0962). At each of the test frequencies, i.e. 250 Hz to 8 KHz, the output sound pressure level (SPL) value was noted. A discrepancy of more than 2.5 dB between the observed SPL value and the expected value (ANSI Standards, 1989), was corrected by means of internal calibration.

Bone vibrator calibration :

The intensity calibration for the bone vibrator (Radioear B-71) was done, for the frequencies 250 Hz to 4KHz. The output of the audiometer was set at 40dBHL.From the bone conduction vibrator (Radioear B-71) the acoustic signal was fed to the artificial mastoid (B and K 4930). This output was then fed via a preamplifier to the sound level meter (B and K 2209). A difference of more than 2.5 dB between the observed SPL value and the expected value (ANSI standards, 1989), was internally calibrated. Thus, the output of the audiometer was maintained within 2.5 dB of the standards (ANSI, 1989).

Frequency calibration :

A time\frequency counter (Radart 203) was utilized to calibrate the frequency of the pure tones. The electrical output of the audiometer was fed to the counter which gave a digital display of the generated frequency. The difference between the dial reading on the audiometer and the digital display of a given frequency, did not exceed + or - 3% of each other.

Sound Field Calibration :

Intensity calibration :

Intensity calibration for speech under headphones was carried out with setting the audiometer output to 70 dBHL. A one inch condensor microphone (B & K 4145) was connected to a sound level meter (B and K 2209) and the octave filter set (B and K 1613). The output SPL was compared for the frequencies 250 Hz to 8 KHz, with the values given by Morgan et al. (1979). A discrepancy of more than 2.5 dB between the observed SPL values and the expected values (Morgan et al. 1979) was corrected by means of internal calibration.

Microphone calibration

Microphone input calibration for speech audiometry was done by presenting a recorded 1 KHz at 70dBHL. The VU meter gain was set so that the needle peaked at '0'. A one inch condensor microphone (B&K 4145) was connected to the sound level meter (B & K 2209) and octave filter set (B & K 1613). The output SPL was noted on the sound level meter on the linear scale and compared with the standards (Morgan et al, 1979). If the reading of exceeded 2.5 dB, internal calibration was done.

Linearity check :

The linearity of the audiometer attenuator was checked. The procedure used was similar to that utilised to check the intensity calibration except that the intensity dial of the audiometer was set at the maximum level and the frequency dial was set to 1000 Hz. The attenuator on the sound level meter was set at a level corresponding to the maximum level on the audiometer. The attenuator setting on the audiometer was decreased in 5 dB steps till 30 dB and the corresponding reading on the sound level meter was noted. For every decrease in the attenuator setting the sound level meter indicated a corresponding reduction.

Frequency response characteristics of earphones :

The frequency response characteristics of the TDH-39 earphone was obtained using B and K signal generator (1023), pressure microphone (B and K 4144) B and K frequency analyser (2107) and a graphic level recorder (B and K 2616). The electrical output of the signal generator (1023) was fed to the head phone. The output picked-up by the microphone (B and K 4145) was fed to the frequency analyser (B and K 2107). This output was recorded on the graphic level recorder (B and K 2616).