PERCEPTION OF MONOSYLLABIC WORDS INI INDIAN CHILDREN

Register No. M 9403

Ayalkanta(Rout)

Dissertation work submitted in part fulfillment of the

Masters Degree in Speech and Hearing

to the University of Mysore.

All India Institute of Speech and Hearing
Mysore, India.
May, 1996

CERTIFICATE

This is to certifry that the dissertation entitled "PERCEPTION OF MONOSYLLABIC WORDS IN INDIAN CHILDREN" is the bonafide work in partial fulfillment for the final year M.Sc. (Speech & Hearing) of the student with register No. M9403.

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

Mysore, India
May 1996

<u>C E R T I F I C A T E</u>

This is to certifiy that the dissertation entitled "PERCEPTION OF MONOSYLLABIC WORDS IN INDIAN CHILDREN" has been prepared under *my* supervision and guidance.

Mysore, India
May 1996

Dr. Asha Yathiraj
(Guide)
Reader, Department of Audiology,
All India Institute of Speech and hearing
Mysore, India

DECLARATION

This dissertation is the result of *my own* study undertaken 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, India
May 1996

Register No. M 9403

ACKNOWLEDGMENTS

I would like to extend my thankfulness and sincere gratitudes to my guide ***Dr. ASHA YATHIRAJ,*** *Reader, Department of Audiology for her constant help and guidance.*

My sincere thanks to ***Dr.(Miss)S.Nikam,*** *Director, AIISH and Head, Department of Audiology for permitting me to conduct the study in the department.*

I am thankful to ***Mr. Shashidhar,*** *Department of Audiology, AIISH who helped me in calibration of instruments.*

My sincere and heartfelt gratitudes to ***Dr.K.Rajalakshmi*** *and* ***Dr.S.R.Savithri,*** *who have extended their everhelping hands to me during the course of this study.*

I would like to acknowledge the great help and support rendered by ***Dr.S.LMohanrao*** *and family during my stay at Mysore.*

I don't find words to thank enough to all my subjects for their patient cooperation and their parents for allowing me to test their children as subjects.

My sincere thanks to ***Mr.Ganeshaiah, Venkatraj, Sheeja, Hia, Kritika*** *and Milli who lent their artistic talents to develop test materials for the study.*

I would like to thankfully acknowledge ***Sumit Dhar*** *of Purdue University, U.S.A. for his timely technical help during the course of this study.*

My heartfelt thanks to ***Pearly Mathew*** *for her tremendous support during the course of this study.*

A final note of thanks from the core of my heart to ***Nirupama, Gopalkrishna*** *and* ***Himanshu*** *- three pillars of support during my stay at AIISH.*

Words are very finite to express my gratitudes to my family members whose expectations, encouragement and belief in my abilities has been the driving force of my life.

Reg. No. M 9403

TABLE OF CONTENTS

INTRODUCTION

> *"The speaker-hearer interaction is the matrix of society. Speech is the leading character in the drama of interpersonal relationships. The speaker is an actor and the listener is an audience. Regardless of the part the speaker may think he is playing, in a way and to a degree is always playing himself. And to this act, the listener always responds"*
>
> *(Travis, 1972)*

The ultimate goal of the speaker in the drama of interpersonal relationship is to make himself understood to the listener. The importance rests on the intelligibility of speech which is considered as an overall measure of how well the speaker can make himself understood to the listener.

Evolution has brought the human voice and ear so in accord that the human voice in its intensity range, its freguency range, and its temporal aspects very nearly exhausts the capacities of the human ear. If the usual speaking voice were much louder, it would seem uncomfortable; if it were lower in frequency, the timbre would sound dull; if it were more rapid, it would mask itself. What minor mismatches exist can be thought of as built in safety factors on the part of the ear. Thus, speech can serve not only as a test for communicability, but also as an extremely handy representative signal with which to examine an ear. For these reasons, speech can be used to examine speech communication, while at the same time, first order information is provided on the ear's reception for many other classes of sound within the dynamic range of speech, such as sounds of nature, traffic, music, etc. (Harris, 1965).

Speech audiometry is an important element in the battery of audiometric tests. It has come into existence because of some inherent disadvantages in pure-tone audiometry. Though pure-tones are physically and mathematically simple and are easy to present, they are relatively uncommon and unimportant. In addition, pure tone audiometry does not provide information about the person's ability to hear above the threshold. On the other hand, speech audiometry helps in earlier detection of slight losses otherwise overlooked and provides better documentation of initial or slight gains after therapy (Carhart, 1965). It helps in a better assessment of differences among hearing aids. Also, in cases of high frequency loss and non-organic losses, speech audiometry yields better results than pure tone audiometry. Moreover, it can be used to determine the patient's ability to perform at supra-threshold levels, and to determine his social adequacy index. The need for speech audiometry arises mainly because speech is by far the most important class of sound that one hears.

An important component of a paediatric audiological evaluation is an assessment of the child's ability to identify speech stimuli. Such tests are important for both diagnostic and prognostic purposes. The speech scores provide information regarding the communicative handicap imposed by the hearing loss, assist in the selection of appropriate amplification, and serve as one of the bases in developing an organised aural habilitation program.

Younger children, commonly exhibit disordered and/or delayed language, their speech is often unintelligible, and written responses to the verbal stimuli are not feasible. These considerations have led to the development of a number of picture pointing tests for moderate to severe hearing impaired children: The Discrimination by Identification of Pictures (DIP) test (Siegenthaler and Haspiel, 1966); the Word Intelligibility by Picture Identification (WIPI) test (Ross and Lerman, 1970); NU-CHIPS test (Elliott and Katz, 1980). They all attempt to circumvent the problems in evaluating children *by requiring a closed-set, picture-pointing response to a word stimulus. All of them also presuppose a level of language knowledge commensurate with the task.*

The present study aims at developing a test of speech perception in English language for the pediatric population in India. It would be a monosyllabic, closed-set, multicolour, picture-identification test.

Justification for the use of English word lists in India

When one intends to use speech stimuli for the purpose of audiological evaluation, meaningful materials are preferred (Egan, 1948; Carhart, 1965). The same is true if one uses speech material for hearing aid evaluation or the assessment of social adequacy. When meaningful materials are chosen to test the speech discrimination ability of a subject, the language used for testing becomes an important variable (Alusi et al., *1974).*

It is preferable to use materials in the individual's native language when his/her speech discri-mination ability is to be assessed. This is because an individual's perception of speech is influenced by his first language or mother tongue (Weinrich, 1954; Delattre, 1964; Singh, 1966; Singh and Black, 1966; Gato, 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 to speech in the same manner. To satisfy this condition, a number of attempts have been made at the construction of speech discrimination tests in different languages such as Arabic (Alusi et al., *1974; Ashoor and Prochazka, 1982), Spanish (Benitez and Speaks, 1968) and Thai (Chermak and Phanjiphand, 1977). Similarly discrimination tests have been constructed in some of the Indian languages such as Hindi (Abrol, 1970; De, 1973), Malayalam (Kapur, 1971), Tamil (Kapur, 1971; Samuel, 1976) and Bengali (Ghosh, 1988).*

Although it is ideal to have speech discrimination tests in all languages, there are some practical difficulties in achieving this ideal. This is because in India, there are fifteen official languages (Manorama Year Book, 1990). Construction of tests in all languages would be time consuming, although the time spent is justified. The use of regional languages in constructing speech recognition tests is also difficult because of variations in dialect. In India there are as many as 1652 dialects (Manorama Year Book, 1990).

Another problem in the use of speech discrimination tests in Indian languages is that the tester should be well versed with all those languages and dialect variations in order to be able to score either oral or written responses of the subject. It would be very difficult to be conversant in all the languages/dialects that one's clientele would possibly speak.

Elizabeth (1983) studied the effect of native language of the tester on scoring the response of a speech discrimination test (NU Auditory Test No. 6) in English. She found no significant difference between the responses as evaluated by the trained and untrained testers. In addition, owing to the small number of speech and hearing centres, one gets cases from various regions where *different languages are in usage. Therefore, a test of regional language would also be of limited utility.*

Furthermore, a large population of school going Indian children have basic vocabulary in English. This is probably because English is being taught right from the primary school. The clinicians are also more proficient in English than other groups of regional languages. Hence, English serves as a better alternative for test materials for speech intelligibility tests in the paediatric population.

Thus, the facts that: (1) English is spoken by many people in India and therefore it is a common language to a large population in India, (2) all *audiologists in India know English, and (3) each centre caters to clients from various language backgrounds including English, justify the need for a speech intelligibility test in English.*

Need for the study

Sporadic attempts have been made by researchers to develop materials for speech identification tests for the Indian population. However, most of them have aimed at developing word lists for adults. Mayadevi (1974) and Malini (1981) standardized monosyllabic word lists for adults. Swarnalatha (1972) developed materials for speech audiometry for both adults and children. But the study had its own limitations. All the above tests reguired either a write-down or an oral response.

While testing speech identification in children, one must consider the response modality to be used. Researchers have recommended use of a picture-pointing, closed-set task for children (Ross and Lerman, 1970; Erber, 1977; Elliott and Katz, 1978; Moog and Geers, 1990). Swarnalatha's (1972) materials for the paediatric population did not have the pictorial representations. Hence, the testing was restricted to an open-set format involving verbal responses. Thus, the need for developing a test of speech perception for the paediatric population using pictures is stressed for the Indian population.

This study would provide a standardized monosyllabic word list along with a picture response book and normative data for the use as a test of speech perception in Indian children. The developed test, thus, would be helpful in evaluation of progress of hearing-impaired children in auditory training programs. The same test materials would be useful in evaluation and fitment of hearing aid and other amplification devices in children.

The test materials would also be useful to evaluate the speech perception of adults with low level of language, inadequate or inefficient speech and mental retardation, provided they have a receptive language age of at least six years.

This study was conducted to answer the following questions:

1. *Is there any relationship between the presentation level and the speech intelligibility scores ?*

2. *At what intensity level do the normal subjects reach their personal maximum scores ?*

3. *What is the most appropriate intensity level at which the test could be administered in clinical situations ?*

4. *Can the test forms be divided into two half-lists without jeopardizing the scores ?*

5. *What are the most common error patterns observed in children when given a forced-choice task ?*

6. *Is there any relationship between the age of the subject and performance ?*

7. *Is there any difference in terms of performance between boys and girls?*

The following null hypotheses were putforth in the study:

1. *There is no significant difference between the mean scores obtained by the subjects at different presentation levels of 12 dB SL, 18 dB SL, 24 dB SL and 30 dB SL relative to Fletcher average.*

2. *There is no significant difference between the performance of girls and boys on the same test.*

3. *There is no difference between the performance of the subjects on first-half and the second-half of the test forms.*

4. *There is no difference between age of the subjects and the performance on the test.*

REVIEW OF LITERATURE

Specially designed speech recognition tests have been in regular use for just over 50 years. However, speech was used as test material for hearing assessment as far back as two centuries ago when Ernaud and Pereire in the middle of the eighteenth century and Itard at the beginning of the nineteenth century used speech to evaluate the effects of auditory training on their patients' speech perceptual abilities (Urbantschitsch, 1895).

It is true that these early attempts in the measurement of hearing of speech have very little in common with what we now refer to as speech tests of hearing. They did, however, stimulate discussion especially among otologists towards the end of the nineteenth century (Gruber, 1891). This debate was also facilitated by a series of timely scientific inventions that had considerable influence on the development of speech audiometry. In 1876 Alexander Graham Bell invented a transducer that converted sound energy to electrical energy and vice versa. In 1877 Thomas Edison patented the phonograph which was later on suggested for use in the measurement for speech (Bryant, 2904).

It is *of interest to note that in 187b, Wolf had suggested that the human voice was the "most perfect conceivable measure of hearing". He constructed a table of intensity values for the various sounds of the German language. The intensity, rather than being expressed in decibels, was expressed in paces or distance from the speaking source. The major testing materials were consonants, syllables and words. Later in 1890, Wolf recorded words on an Edison wax cylinder. He was able to present the words to the ear of the patient through adjustable tubing which permitted control of the intensity of recorded materials" (O'Neill and Oyer, 1966).*

The speech stimuli available as test materials range from very simple to very complex items. At one extreme of the stimulus dimension are the phonemes, syllables, and words, all of which are widely used in evaluative measures (Erber, 1977). These brief stimuli are preferred because (1) many can be presented within a short amount of time; (2) they are easily scored with a right-or-wrong criterion; (3) they can easily be presented within a closed set format; and (4) numerous distinctive feature theories are available to help the examiner explain a child's perceptual confusion. The main drawback of such simple stimuli is that they do not form the typical content of everyday speech communication.

At the other extreme of the stimulus dimension are phrases, sentences and connected speech, all of which are very desirable as test materials because they represent the stimuli that a hearing-impaired child normally encounters in daily conversation. The main difficulty with using such speech materials is that the scoring of large language units, such as sentences, may not be an easy task.

While developing a test of speech perception, the researcher should take into serious consideration, the response elicitation modality. It depends on numerous factors such as age group, literacy, disability of the subjects. There are four basic types of responses that contribute to perception of conversational speech. They are: detection, discrimination, recognition and comprehension (Hirsh, 1966; Boothroyd et al*., 1971).*

DETECTION is the ability to respond differently to the presence and absence of a speech stimuli. It may result in child orienting to the speaker in order to acguire more speech information from him (Hirsh, 1966)

DISCRIMINATION requires a same-different response. It refers to the ability to perceive similarities and differences among two or more speech stimuli. This important skill allows the child to discover that different words phrases have different acoustic qualities, visible characteristics, intensities or durations. For example, the child may be asked, "Do these words seem to be the same or different: feather/father ?" (Hirsh, 1966)

RECOGNITION is the ability to produce a speech stimulus by naming or identifying it in some way. A child's recognition response may take the form of pointing at, writing, or repeating the speech that was presented. Recognition is the most common form of response employed in present-day clinical evaluation (Hirsh, 1966).

COMPREHENSION is the ability to understand the meaning of a speech stimulus, usually by reference to knowledge of language. To indicate comprehension, a child's response must be qualitatively different from the stimulus that was presented but must be closely associated with it in some way. That is, the child cannot simply repeat the stimulus but must demonstrate that he understands by responding, usually to a question or instruction (Hirsh,1966).

A wide range of speech identification tests have been developed all over the world. These tests differ from each other depending on the stimulus material, response modality, targetted age group, language and manner of presentation of the stimuli. The initial attempts in the early 1900s were successful in testing the adult population. Soon, tests were developed to cater to the psdiatric population as well as to overcome the inherent limitations of the previous tests.

It is interesting to note that various terminologies have been used to describe the speech discrimination tests, viz., articulation testing, intelligibility testing, speech discrimination tests, speech identification tests, speech recognition tests, speech perception tests. However, the currently accepted term is "test of speech perception" as it most closely explains the nature of the test as well as the task for the subject (Penrod, 1983).

FACTORS TO BE CONSIDERED WHILE DEVELOPING A TEST OF SPEECH PERCEPTION

While developing a 'test of speech perception' the researcher must take several factors into consideration. The target population for which the test is being developed; the language in which the test is to be constructed; type of speech material to be used as stimuli; transmission of the stimuli; presentation levels; choice of response modality; statistical analysis are to be decided before developing the test.

I. TARGET POPULATION

Materials for speech audiometry should be selected in such a way that it should be within the linguistic abilities of the subjects. In this context, a basic dichotomy separates the materials developed so far: adults vs children.

Developing materials for adults is relatively easy because of the availability of v/ide variety of stimuli. Whereas, for children one has to consider the limited vocabulary and linguistic competence.

Several tests have been developed for the adult population. One of the early ones that was developed at Psycho Acoustic Laboratories (PAL), Harvard, where series of lists were constructed and underwent numerous revisions. These were the revised monosyllabic word lists (Egan, 1948). From a core vocabulary of 1200 words, 24 lists of 50 words each were produced.

Egan (1948) further modified these lists and the well known PAL PB-50 lists were developed. The PB lists were devised to meet the following criteria: monosyllabic words, equal average difficulty, range of difficulty and phonetic composition of each list as well as representative of English speech, using words in common usage.

The PAL PB-50 list had some limitations. The researchers at the CID worked on to revise the original PAL list to overcome the limitations. This modified list became CID Auditory Test W-22. The criteria for vocabulary of the revised lists were that all words be of one syllable, that none appear on more than one list, that all words be familiar, and that the phonetic composition of each list be representative of English. The vocabulary consisted of 120 words selected from the original 1000 words of the PAL PB-50 list and 80 additional words.

Apart from the above word lists, lots of other lists have been developed for testing the adult population. Lehiste and Peterson (1959) developed CNC word lists.

In creating the NU Auditory Test No. 4, Tillman et al. (1963) developed from these words a list of 95 words, plus some additional words. A total of 16 test lists were developed from this original work; included among them is the NU Auditory Test No. 6 (Tillman and Carhart, 1966)

Two of the more widely used discrimination tests are the Rhyme Test developed by Fairbanks (1958) and the Modified Rhyme Test developed by House et al. (1965).

Specialized test lists for different frequency regions were prepared by Glaser (1974) to assist in hearing aid selection. An abbreviated list for screening purposes was prepared by Rose (1974). In addition to these, there are specific types of sentences, multiple choice lists and CAD test lists.

Swarnalatha (1972), Mayadevi (1974), Malini (1981) have standardized English word lists for Indian population. Similarly, speech intelligibility tests have been constructed in some of the Indian languages such as Hindi (Abrol, 1970; Be, 1973), Kannada (Nagaraja, 1973), Malayalam (Kapur, 1973) and Tamil (Kapur, 1971; Samuel, 1976).

Various materials have been devised specifically for use with young children. Some of these are commercially available in recorded form, and normative data are provided. Other tests consist simply of printed lists which may be administered by monitored live voice or by self recorded presentations. The available stimuli consist of monosyllabic words (Haskins, 1949; Siegenthaler and Haspiel, 1966; Ross and Lerman, 1970; Goldman et al., 1970; Katz and Elliott, 1978), sentences (Weber and Redell, 1976; Jerger *et al., 1980), numbers (Erber, 1980) and environmental sounds (Finitzo-Hieber et al., 1980). Both open (no options given) and closed set (forced choice) response formats are employed, and the response mode may be verbal or psychomotor (pointing).*

The selection of materials depends on the linguistic sophistication of the subjects. In general, with increased language development, there is a wider variety of applicable materials. A factor which must be considered when selecting materials for children is whether the patient has intelligible speech since its presence will permit the use of *an open-set response format and allow for more precise assessment (Penrod, 1990).*

Watson (1953) constructed discrimination tests using monosyllabic words taken from the vocabulary of 5-year old children. It was also found to be useful for children with impaired hearing.

Watson, Murray, Reed, Keaster (1947); Sortini and Flake (1953); Siegenthaler, Pearson and Lezak (1954); Ross and Lerman (1970); Katz and Elliott (1978) constructed speech tests for young children in which the child has to point to a picture or an object after hearing the stimulus word.

A review of speech identification tests shows that the attempts at modification can be divided into categories. One was to modify the testing procedures to make them more appropriate for children. As many hearing-impaired children cannot repeat spondees or monosyllabic words, tasks using 'non-verbal' responses, i.e., picture pointing, have been developed. A second attempt involved a modification of the test stimuli.

II. TYPE OF STIMULUS MATERIAL

Various stimuli have been used for speech identification testing, viz., nonsense syllables, environmental sounds, monosyllabic words and sentences.

a. Non-sense syllables

The use of non-sense syllables in the study of intelligibility represents an analytic approach in which the interest is focussed on the intelligibility or repeatability of specific phonetic elements. The advantage of using nonsense syllables lies in the fact that they are devoid of meaning and hence their intelligibility is in no way dependent upon the vocabulary of the listener. Furthermore, *the non-sense syllables are non-redundant,* a property *essential for a test of speech discrimination (Carhart, 1965). Also, it is* *easier to construct lists of comparable difficulty using non-sense syllables than by using meaningful material (Egan, 1948).*

On the other *hand, non-sense syllables have the disadvantage of being unfamiliar to the listener. They are often abstract and are very confusing to* the listener *(Carhart, 1965). They need special training to be read out in the intended way.*

It has been found in practice by Lafon (1966) that nonsense syllables are by no means easy to use because the subject has an unconcious tendency to look for a meaning in the sound presented to *him and to reproduce it as a known term.*

Edgerton and Danhauer (1979) developed a Nonsense Syllable Test (NST) which consisted of 25 items of CVCV stimuli. The materials were constructed from non-meaningful stimuli.

Danhauer et al*.* (1984) *assessed* the *monoaural performance of seven girls* (8.8-14.8 years) *with mild to moderate hearing* loss *and found NST to be useful in assessing childrens' phoneme perception.*

Butts et al*. (1987) compared the errors on an NST to pure tone thresholds of 109 subjects with normal hearing or SN hearing loss. Excellent predictive relations were found between total NST* errors *and weighted* pure tone averages for *slight to marked SN hearing loss.*

Dubno et al*. (1982) reported that, subjects with steeply sloping audiometric configuration showed consistently poor performance than those with flat hearing loss. NST was found to be sensitive to high frequency SN hearing loss.*

The above studies reveal that the NST has been found to be useful for *evaluating both adults and children. However, when used with children, it requires some modifications, viz., monitored live voice presentation and familiarization of items. This test is better suited for older children as against younger ones.*

b. Monosyllabic words

Monosyllabic words are less analytic units of speech and are more easily repeated than non-sense syllables. Therefore, many researchers have preferred to use monosyllabic words. Carhart (1965) recommends the use of phonetically balanced monosyllabic word list. He wrote:

"A test of discrimination for speech as opposed to a threshold test must consist of relatively non-redundant items. Otherwise, the multiplicity of clues available to the patient will obscure many of his inabilities to differentiate consonants and vowels accurately". (Carhart, 1965; p. 253)

Monosyllabic words are sufficiently unpredictable for clinical subjects so that individual speech elements must be perceived relatively independently. On the other hand, "they are not as confusing as nonsense syllables, which are so abstract that they baffle many subjects" (Carhart, 1965, p. 253).

By using monosyllabic words it is possible to construct word lists that are highly familiar, as well as phonetically balanced. Moreover, they can be easily manipulated to represent colloquial speech (Giolas, 1975). They enable rapid determination of identification scores and/or articulation function (Boothroyd, 1968). Tobias (1964) *stated that, "... monosyllabic words are useful in that they are a specific form of speech because they are a good* representation of everyday conversational speech". Some of the commonly used monosyllabic word lists are the PAL PB-50 (Egan, 1948); CID W-22 (Hirsh et al., 1952); NU-4 & 6 (Tillman et al., 1963; Tillman and Carhart, 1966).

A number of monosyllabic word lists have been developed for the pediatric population. The popular ones being those developed by Haskins (1949), Fairbanks (1958), Siegenthaler and Haspiel (1966), Ross and Lerman (1970), Goldman et al. (1970), Katz and Elliott (1978). Thus, it is evident from the review that, the use of monosyllabic words are popular when constructing speech identification tests for children.

c. *Disyllabic words*

Disyllabic words have been more popular as stimuli for speech reception threshold than for discrimination testing because of the redundant cues they provide. They are less analytic than the monosyllabic words and provide additional cues for intelligibility. In order to repeat a monosyllabic word correctly one must hear each of the phonetic elements. A word of two syllables, however, can be distinguished from other two syllable words not only on the basis of phonetic elements but also on the basis of stress pattern (Hirsh,1952).

Disyllabic words have been found to yield higher intelligibility than monosyllabic words under the same conditions. But it does not give an accurate measure of a person's speech intelligibility as there is greater amount of redundancy present in these stimuli (Penrod, 1990).

The use of disyllabic words in speech discrimination tests has been mainly due to language restrictions, i.e., in some languages adeguate number of concrete monosyllabic words are not available. Comstock and Martin (1984) developed a picture pointing speech discrimination test which can be efficiently administered by English speaking clinicians to Spanish speaking children. The test consisted of four lists of 25 disyllabic words.

Pearly (1996) developed a similar material in Malayalam for children, which consisted of two test forms. Each form included the same 50 picturable disyllabic words in different randomization. (Personal communication).

d. Distinctive features

McPherson and Pang-Ching (1979) developed a distinctive feature discrimination test (DFDT) where error responses could be evaluated in terms of their distinctive feature differences from a stimulus item. The DFDT was developed for the adults. It was helpful in:

1. determining whether different pathologies show different patterns of feature confusion.
2. indicating an individual's feature confusion which, in turn should prove planning his rehabilitation program.
3. providing a more sensitive estimate of the severity of the individual's discrimination problem.

In the DFDT four test lists were constructed by choosing 50 monosyllabic CVC stimulus words and three rhyming error responses for each stimulus word. Of the 50 stimuli in each list, 25 have the initial consonant as the variable phoneme while the other 25 have the final consonant as the variable phoneme. The distinctive features were those proposed by Miller and Nicely (1955): voicing, nasality, affrication, duration, place of articulation.

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, word-picture format. The test examines perception of speech envelope versus spectral patterns as well as suprasegmental (prosodic) versus segmental (phonemic) elements. This test was developed in such a manner that, it could disclose the slightest remnant of speech perception ability. It tested 10 distinctive features:

Time pattern	*- 'cat/caterpillar'*	*Nasality*	*- 'lock/knock'*
Duration	*- 'sheep/ship'*	*Voicing*	*- 'bear/pear'*
Intensity	*- 'dog/dig'*	*Manner*	*- 'dog/log'*
F_0	*- '125 Hz/250 Hz*	*Place*	*- 'boat/goaf puretone*
F_1	*- 'books/box'*		
F_2	*- 'she/shoe'*		

The speech discrimination tests based on distinctive features thus have an advantage over other tests of discrimination in that they not only give the quantitative account of speech discrimination but also a *qualitative analysis of the error patterns. Thus, they help in knowing the most frequent perceptual* errors *and planning appropriate rehabilitation strategy for the hearing impaired.*

e. Sentences

The use of single words, and especially single syllable words, imposes severe limitations on the capacity to manipulate a crucial parameter of ongoing speech - its changing pattern over time. In order to add this dimension to speech audiometry it is necessary to develop materials based on relatively longer samples of speech than words.

Furthermore, the relation between word lists used in the measurement of intelligibility and the continuous flow of words encountered in conversation is not clear. Sentences are considered to be more valid indicators of intelligibility.

Sentences were used by the Bell Telephone Laboratories (Fletcher and Steinberg, 1929) in their early work. These early lists consisted of interrogative sentences that were not to be repeated by the subject but to be answered. These lists were not found so useful for the clinician because the test demanded not only that the subject hear the words of the sentence, but also that he provide answers to some fairly difficult questions. Simpler lists of sentences were constructed for the adults at the Psycho Acoustic Laboratory by Hudgins et al. (Auditory Test No. 12). The questions were relatively simple and can be answered by a single word. This feature makes them useful when a written test for use in group testing is desired.

Berger (1969) developed the Kent State University (KSU) speech discrimination test for the adult population. It employed five key words within a series of sentences. The test consists of 150 sentences. Each sentence contains a key word which is so chosen that four other words could also be used in its place, retaining the meaning fulness of the sentence. The subject chooses one of these five sentences, which he thinks he has heard. The test has eight equal forms with thirteen sentences in each form which are arranged in an order of progressive difficulty (Berger, 1969).

Berger, Keating and Rose (1971) observed that the KSU test was less sensitive to hearing impairment, when compared to CID W-22 lists. However, this test was better than W-22, in predicting how efficiently one could use his hearing for communication purposes.

Jerger et al. (1980) published the Pediatric Speech Intelligibility Test (PST) which used both word and competing message sentence material. Two groups of sentences, i.e. for low *and high 'receptive language ability' children were used.*

Bench, Koval and Bamford (1979) developed the BKB sentence list in UK. It consisted of 21 lists of 16 sentences (not more than seven syllables in each sentence). Each list contains 50 stimulus words. The scoring was achieved by calculating the percentage of key words repeated correctly.

Speaks and Jeger (1965) introduced the Synthetic Sentence Identification Test (SSI) for adults. The test materials were not real sentences in that they did not make any sense, but they were in a sentence format. The words used to formulate the synthetic sentence were selected following specific syntactic rules. The SSI uses a closed set format.

Kalikow et al. (1977) developed an open set response sentence test called the Speech Perception In Noise (SPIN) test for adults. It comprised of eight sets of fifty sentences. Half of the sentences contain items with high predictability, and half contain items with low predictability based on contextual, syntactic and prosodic cues. The background noise was a 12 talker speech babble.

In summary, sentences have been used as stimuli to test speech intelligibility. They are more representative of the conversational speech. But majority of the sentence tests are developed for the adult population.

f. Other stimuli

Apart from the above categories, researchers have used environmental sounds, numbers, alphabet letters as stimuli.

Finitzo-Hieber et al. (1980) developed the Sound Effect Recognition Test (SERT). It is a non-linguistic test and utilizes thirty environmental sounds (plus one practice item). The thirty environmental sounds are divided into three lists with each list consisting of ten items represented on four picture matrix plates. This test is for very young children around three years of age.

SERT suffers from the limitation that, it does not test the speech perception ability. Further more, it has no way to represent the conversational speech.

On the other hand, it is very useful for children and represents environmental sounds spreading over a wide spectrum of frequencies.

Erber (197b, 1977, 1980) developed a series of tests named Auditory Numbers Test (ANT). The most popular being ANT-1980. This is a simple test specially designed for children with severe to profound hearing loss and who owing to severe linguistic retardation are unable to respond to traditional word recognition tests. It is suitable for children in the age range of 3-8 years who can count from 1 to 5.

In an effort to develop a speech perception test for children which is more difficult and discriminating than a closed set test such as WIPI, but also not as difficult as an open set PB-K words, Ross and Randolph (1990) developed the Test of Auditory Perception of Alphabet Letters (APAL test). APAL requires the identification of spoken alphabet letter names. Responses may be obtained orally, by finger spelling or preferably by pointing towards alphabet letter on a response board. Because hearing impaired children are taught to recognize alphabet letters at an early age, these items should be particularly suitable in terms of familiarity. Furthermore, as acoustic stimuli, the spoken names of *alphabet letter incorporate wide variations in perceptual difficulty, ranging from multisyllabic 'W to such difficult perceptual tasks as recognising and differentiating 'F' and 'S'.*

Moog and Geers (1990) developed the Early Speech Perception Test (ESP) for young profoundly hearing handicapped children with limited vocabulary. The ESP test battery consisted of a pattern perception subtest and two word identification subtests. There are three stimuli in each of the subparts, i.e., monosyllables, trochees, spondees and trisyllabic words. The materials used are pattern perception picture card, spondee identification picture card, monosyllable identification card and a score sheet.

Moog and Geers (1990) designed a 'Low-Verbal ESP' test for estimating speech perception abilities in very young children (as young as 2-3 years). Real objects were used as stimuli which would hold the interest of the subjects. The authors recommended thai if a child scores above 75% in the last level of ESP, he/she can be further tested using WIPI (Ross and Lerman, 1970) or NU-CHIPS (Elliott and Katz, 1980).

III. PHONETIC BALANCING VS. PHONEMIC BALANCING IN WORD LISTS

*Phonetic balancing refers to the appearance of a sound in a list with respect to its proportion of occurrence in everyday speech. Egan's (*l948) *phonetically balanced lists were devised to meet the following criteria: monosyllabic words, equal average difficulty, range of difficulty and phonetic composition of each list. Grubb (1963) defined phonetic balancing as 'proportional representation of fundamental speech sounds'.*

The requirement of phonetic balance was the most difficult to meet since no definitive study of spoken English existed. Hirsh et al. (1952) relied on

Dewey's report of frequently occurring words in print and the report of French et al. (1930) of the most frequently occurring sounds in telephone conversations. The necessity of phonetic balance has been questioned, and there is no agreement on this point. Tobias (196k) indicated that phonetic balance is an interesting but unnecessary component. Carhart (1965) stated that "In general as long as the tests items are meaningful monosyllables for the patient and their phonetic distribution is appropriately diversified, one 50 word compilation is relatively equivalent to another" (p. 25k).

Phonemic balancing refers to the appearance of a phoneme in a list with respect to its frequency of occurrence in a particular language. Lehiste and Peterson (1959) pointed out that phonetically balanced lists are really not possible since a particular speech sound will vary depending upon the sounds that precede and follow it. Rather than phonetic balance, they advanced the concept of "perceptual phonetics" or "phonemics" and strove to develop 'phonemic ally balanced lists'. The materials .used by Lehiste and Peterson (1959) were all of the CVC variety and were referred to as CNC words since they identified the vowel as the 'syllable nucleus' in a word. Their CNC words were drawn from the Thorndike and Lorge (1944) lists and included all CNC words appearing at least once per million words. This provided a pool of 1263 CNC monosyllables. Phonemic balance was based on the composition of these words rather than on English as a whole.

Lehiste and Peterson (1959) constructed ten lists of fifty words which confirmed closely to the phonemic balance of the entire group of monosyllables. Later, these initial lists were revised in an effort to eliminate unfamiliar words (Peterson and Lehiste, 1962).

Not all authorities agree upon the necessity for phonetic balancing. Berger (1971) argued well that any sizable sample from conversational vocabulary would be, by definition, a phonetically balanced sample of spoken English. It will now be necessary to investigate further the relevance of phonetic balance. Black and Heagen (1963) and Lafon (1966) argue that open should no longer choose the words on the basis of a phonetic balancing of the word lists, but on the basis of the information they carry.

IV. HALF LIST VS. FULL LIST

There has been considerable controversy as to whether, utilizing a half list is likely to affect the speech discrimination scores.

In an effort to reduce clinical testing time and to avoid patient fatigue, it has become common practice for many audiologists to use only half of a 50-item speech discrimination list (Penrod, 1983).

This procedure has come under scrutiny of a number of researchers using a variety of subjects. Investigations have been carried out for PAL PB-50 (Resnick, 1962; Shutts et al., 1964; Burke et al., 1965), CID W-22 (Elpern, 1961; Deutsch and Kruger, 1971; Margolis and Millin, 1971; Jirsa et al., 1975; Penrod, 1980), NU-6 (Schumaier and Rintelmann, 1974; Jirsa et al., 1975; Schwartz et al., 1977; Beattie et al., 1978) and PB K-50 (Manning et al., 1975). Presently no consensus exists regarding the clinical use of half-list testing. Some authors have advocated its use while others have advised against it and some have recommended its use but with certain cautions.

Considerable savings of time can be realized with the half-list procedure but not without risks. There are two concerns: (1) whether the results *are valid and (2) whether they are reliable. Thornton and Raffin (1988) point out the trade off between measurement error and sample size. As sample size is reduced, variability in scores increases, and the farther the score from 100% or 0% the less confidence one can have in the specific value. However, Elpern (1961) pointed out that a 25-word list was as effective as a 50 item list, based on his analysis of W-22. Companelli (1962) obtained similar results on the PB-50 lists. Employing only 25 words was considered to save time.*

Katz and Elliot (1980) reported that half-list of NU-CHIPS test is equally reliable as compared to full list across all four test forms.

Tobias (1964) opined that phonetic balance was not essential factor in a "useful diagnostic test". Thus a half list was considered as informative as a full list.

Grubb (1967) contradicted the findings of Elpern (1961), Campanelli (1962) and Tobias (1964) and reported that the two half lists may not be equally difficult or equally easy. Also, the list would no longer be phonetically balanced.

Martin (1975) favours the administration of the full list by stating, the full list takes no more than five minutes to administer, which is not a considerably long duration.

From the above review,it is evident that researchers vary in their opinion regarding whether a half list is as useful as a full list. Their findings may have varied due to the difference in the test used by them. A half list may be used only if the two halves have equal representation of phonemes and difficulty of the test items.

V. NECESSITY OF HAVING SEVERAL LISTS

The need for several lists arises when one determines the articulation function of an individual. It is of paramount importance that the same list should not be used more than once on an individual, for his memory may play a factor and improve his scores on successive presentation of the list (Langenbeck, 1965; Tillman et al., 1963; Tillman and Carhart, 1966).

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

Lehiste and Peterson (1959), in their auditory test, constructed ten lists of 50 words, each in all of which, *the phonemic balance was rigidly maintained. The phonemic structure of CNC words occurring with a minimum frequency of one* per *million according to the Thorndike and Lorge (1964) frequency count. However, Elkins (1970) questioned the interlist difference with reference to the number of familiar words each contained. Peterson and Lehiste (1959) considered the overall familiarity of their 500 words, but did not take into account the interlist difference.*

Rintelmann et al., (197b) evaluated all the four forms of NU-6 and found them to be equivalent. They also found the four forms of the same test to yield similar results across a range of sensation level of 0 dB to 32 dB (re:SRT).

Malini (1981) studied the interlist differences using form A of NU-6 on Indians. She found a statistically significant difference between lists at low SLs and not so at higher sensation levels. At low presentation levels, she found list IV to be easier and list I to be the most difficult. The difference in the outcome of the above two studies could be attributed to the subject variability. Malini (1981) used non-native English speakers whereas Rintelman et al., (1974) used native English speakers. Katz and Elliott (1980) used four test forms each including the same 50 monosyllabic nouns in different randomization in their NU-CHIPS test. The four test forms upon statistical analysis revealed equivalent means and equivalent variances.

Various researchers have stressed on the need of having several lists which must be phonemically balanced and equally difficult to subjects. This would help to overcome the practice effect.

VI. TRANSMISSION OF THE STIMULI

a. Recorded vs. monitored live voice testing

Speech perception tests may be administered not only by means of phonographic or tape recorded presentation but by monitored live voice (MLV). The use of the latter has been prevalent due to its flexibility, rapidity and ease of administration. The main advantage of MLV testing is its flexibility. For example, the use of MLV testing with very young children and with many aged persons often provides information quickly, which otherwise might require a considerable period of conditioning or else be unattainable (Goetzinger, 1973). A great deal of information is available, especially with respect to the talker variations. Carhart (1946a, p. 349) indicated that "Phonographic presentation increases the stability of the condition but tends to reduce the flexibility of the technique" but was of the opinion that both procedures had clinical utility. Carhart (1965) also pointed out that test results obtained by different talkers are not readily comparable unless the equivalency of the talkers has been demonstrated.

Each speaker's intonation, pronunciation, accent, and physiological conditions are likely to be variables that affect the scores. In MLV presentation, there is a strong tendency for the speaker to try and articulate more clearly when the patient does not understand clearly (Langenbeck, 1965). Brandy (1966) demonstrated that a single talker's presentations of the same words will vary at different times.

The best method to eliminate the speaker being a variable, is by making use of a single speaker's recorded speech. This makes comparison among results of different examiners possible (Carhart, 1965; Langenbeck, 1965).

Northern and Battler (1974) have called for a standardized, recorded that or tests and specified that the answer does not lie in the development of tests but with tests which are currently available.

The unigue characteristics of the talker is a constant variable in each recorded test. There is every possibility of there being as much difference between one recording and another as between two live voice talkers (Carhart, 1965) . Such a discrepancy has been demonstrated by the Rush Hughes recording of the PB-50 and the W-22. The former was compiled by Davis et al., (1948) and the latter by Hirsh et al., (1952). The scores were found to improve rapidly with increase in presentation level in W-22 list, and were near the SRT. The Rush Hughes version was more exacting.

The above review suggests that both recorded materials as well as monitored live presentation have their own merits and pitfalls. But, due to the greater flexibility and manipulability of the monitored live voice, it would be an ideal method to present the stimuli to young children in particular.

b. Speaker variability

The qualities of the operator's voice are of direct influence - the sex, articulatory pronunciation, volume capacity, regional accent, variation of intensity have empirical effects on the scores.

French and Steinberg (1947) used male and female speakers in their speech test and noticed differences in the listener's scores. They reported that men's voices are about one octave lower in pitch than women's and the latter tends to be somewhat richer in high frequency sounds.

Kreul et al. (1969) employing one of the lists of the modified Rhyme Test, which was developed by House et al. (1965), found that the test difficulty did not change significantly with reutterances of the same materials by a given speaker over two recording sessions. Their findings were not in agreement with that of Brandy (1966), who found that there was a difference in the utterance of two speakers. The differences in the findings could be due to major procedural differences that existed in the two studies. The recordings of Kreul et al. (1969) were carefully monitored and intensity and articulation of the talker was closely controlled. The "live voice" present-ations of the Brandy (1966) study underwent no acoustical corrections for intensity. Probably of greater importance is the fact that Kreul et al. used the MRT, a closed-set response test, while Brandy used 25 selected monosyllables from the list III of CID W-22.

Variables such as vocal parameters and regional dialects are factors that contribute to the speaker variability. Hecker (1974) determined the consonant-vowel ratio of the recordings of two male speakers of the 300 monosyllabic words of the Modified Rhyme Test, utilizing an interactive computer system. The consonant vowel ratio was computed by measuring the energy in the appropriate consonant and vowel segments. The speaker with a higher consonant vowel ratio was found to be more intelligible.

Penrod (1979) investigated talker effects with CID W-22 and subjects with varying degrees of SN hearing impairment. Recordings were made of four talkers' clinical presentations which were then presented, unaltered to listeners in randomized order. Although the mean scores obtained by the listeners for the four talkers were not significantly different statistically, there were excessive variations in scores for individual listeners when compared to results of Thornton and Raffin (1978).

Joseph (1983) studied the talker difference on the scores obtained by Indian subjects on NU Auditory Test No.6. She found a significant difference between the male and female talker. The scores obtained with the female talker were more intelligible than that obtained for the male talker.

c. Carrier phrase

Another variable which may affect speech discrimination scores is the use of or omission of a carrier phrase and it needs to be considered while constructing a test of speech perception. Fletcher and Steinberg (1930) reported that identification of CVC syllables was higher when using an introduction sentence. Typically, during speech perception testing, a carrier phrase precedes the stimulus word. The most commonly employed carrier phrases are, "say the work ______", "you will say______", "write the word______", and "show me______".

Egan (1944) and Carhart (1952) utilized carrier phrases in Speech Audiometry with the intention of alerting the listener for the test word, and allowing the announcer to monitor his voice. The exact content of the carrier *phrase was not given much consideration. Studies conducted at a later stage indicated that the operation of a preceding phoneme on a succeeding one, did influence the intelligibility of speech (Pederson, 1970; Gladstone and Siegenthaler, 1971). With a change in the carrier phrase, a variation in the discrimination scores has been noted by Kruel et al. (1969) employing the Modified Rhyme Test.*

Gladstone and Siegenthaler (1971),using the CID W-22 found a difference of score of 7% as a function of carrier phrase, i.e., using different carrier phrases. An improvement of 16% was found in intelligibility when the more enhancing carrier phrase was compared with scores of the same words with no carrier phrase. They extrapolated that the intelligibility of the carrier phrase "You will say______" enhanced the scores, as the long vowel \E\ at the end, in contrast to other endings, helped in augmenting the intelligibility. Gelfand (1975) obtained similar results, when comparing words in isolation with those spoken with the carrier phrase "say the word______".

Lynn and Brotman (1981) indicate that the carrier phrase "You will say ______" contains perceptual cues that may assist the listener in identifying some initial sounds of test words. This is because of the placement of a prevocalic consonant (CV) in a phrase such as "You will say CV". The consonant here, is considered an intervocalic consonant (V CV), with the nucleus of the word "say" being V , and the nucleus of the test word being V . In addition, the findings of Ostreicher and Sharf (1976); Sharf and Beiter (1974); Sharf and Hemeyer (1972) have demonstrated that VC formant transitions provide more consonantal place of articulation information than do CV transitions. This finding substantiated the extrapolation of Gladstone and Siegenthaler (1971).

Kreul and Moll (1972) have speculated that the carrier phrase contains acoustic cues for some manner of articulation distinction for initial consonants and also for the tongue advancement cues for syllabic nuclei of the test word. Lynn and Brotman (1981) have also postulated that the phrase "You will say ..." contains perceptual cues that enhance identification of place of articulation of the initial consonant of the test word.

However, contrary to the above findings, Martin et al. (1962) have found that carrier phrases are non-essential and only serve to confuse individuals who have severe discrimination problems.

McLennan and Knox (1975) also studied the effects of omission of the carrier phrase. They compared the performance of normal-hearing and sensori-neural impaired listeners using a conventional presentation (carrier phrase-examiner controlled rate) and a free operant procedure in which the subject had control of the stimulus presentation and therefore was free to respond at his own rate. In the free operant procedure there was no carrier phrase used and the subject had a control switch to operate the record player. The advancement of the tape was dependent on the subject. Hence, the subject responded at his own rate with an adeguate inter-stimulus interval. The scores obtained by normal-hearing as well as sensori-neural impaired listeners were unaffected by the omission of the carrier phrase using free operant procedure.

Lynn (1962) reported a modification of the testing procedure which was designed to save time but still employ the complete fifty-item list. The carrier phrase was maintained but the test items were presented two at a time in his "paired PB-50 discrimination test".

To summarize, researchers vary in their opinion regarding the usage of carrier phrase. Those favouring usage of it argue that the carrier phrase acts as an alerting pre-stimuli. Those not favouring its usage do so, because of greater *time required for testing.*

d. Presence of *background noise*

When a competing noise is presented along with stimuli, the speech intelligibility gets affected (Carhart and Tillman, 1970; Keith and Tabis, 1970; Northern and Hattler, 1970; Rupp and Phillips, 1969). It has also been demonstrated that different background noises have different effects on speech intelligibility for normal hearing adults (Williams and Hecker, 1968).

Miller et al. (1951) demonstrated that the PI function varies depending on the signal to noise ratio. The variations occurring due to the presence of noise are also influenced by the type of hearing loss. As the *S/N ratio becomes less favourable, the effects on speech intelligi-bility are more pronounced in sensorineural-impaired subjects than for normally hearing subjects (Olsen and Tillman, 1968).*

Not only is the S/N ratio a factor, but the type of masking noise used has also been shown to affect performance (Lovrinic et al., 1968; Williams and Hecker, 1968; Garstecki and Mulac, 1974). The performance of a single group of subjects was compared on five measures of speech discrimi-nation by Lovrinic et al. (1968). Although the vocabulary for the two CID W-22 lists used in this study has been shown to be very similar with respect to difficulty (Ross and Huntington, 1962). Large differences for materials, presented in the presence of masking noise at a +12 dB S/N ratio vras found. Lovrininic et al. (1968) observed *not only markedly poorer performance but almost an absence of "easy" items in the presence of ipsilateral speech babble noise.*

Dirks and Bower (1969) have given evidence that the noise background had no influence on the synthetic sentence discrimination when the speaker of the sentence material and competing message are the same. However, Garstecki and Mulac (1974) illustrated that synthetic sentence discrimination in forward competing message mode was a rather difficult task for both normal hearing individuals and those with mild to moderate sensorineural hearing loss.

In summary, the literature suggests that when a competing noise or stimulus is introduced, the speech discrimination efficiency deteriorates. Hence, this principle can be utilized to study speech perception in central auditory dysfunction by stressing the auditory system.

e. Presentation level

The effects of presentation level on understanding of different stimulus materials can easily be visualised by employing the Performance-Intensity (PI) function. Discrimination scores established at low sensation levels yield poor scores. With a rise in presentation level, the scores also increase steadily. At a particular point, an increase in the intensity does not bring about an improvement in the discrimination scores (Carhart, 1965; Boothroyd, 1968). This particular point has been referred to as PB Max when phonetically balanced words are employed.

Maximum intelligibility was reached at 60 dB SPL on CID W-22 lists. Above this intensity level, no appreciable improvement in score was noted. However, below 60 dB SPL, the slope of the curve was steep, indicating the dependency of discrimination scores on intensity (Giodas, 1975).

While determining the articulation function from -4 dB SL to +40 dB SL, for the NU-4 test, Tillman et al. (1963) found it to be linear, which underwent saturation at higher signal intensities. "Almost perfect discrimination" was obtained at +24 dB SL.

Tillman and Carhart (1966) found that the four lists of NU auditory test no. 6 gaveforth, essentially a similar articulation function as did the NU 4 test. A asymptote was reached at 32 dB SL. Variability in scores was found to be greater at lower SLs.

Katz and Elliott (1960) reported that normal hearing children performed at the test ceiling at 30 dB SL on the NU-CHIPS test. At SLs lower than 30 dB an age effect was manifested, where ten-year olds performed better than five-year olds who in turn performed better than three-year olds. Because of this developmental effect, they recommended that NU-CHIPS be administered at 30 dB SL or higher, relative to the Fletcher Average

It is not always practical to obtain an articulation function in routine testing (Boothroyd, 1968). Thus it has been suggested that for routine testing purposes, speech intelligibility be obtained at one particular level. Davis (1948) has recommended that, while administering the PAL PB-50 word list, 110 dB SPL be used for cases with hearing loss of 55 dB or less and 120 dB SPL for hearing losses greater than 60 dB unless the latter causes discomfort. However, Carhart (1965) pointed out that by making use of just one intensity level, one cannot be sure that he is determining the maximum discrimination score of the individual, unless he has got a score of 100% at that level. If the scores are lower, there is no way of knowing whether it presents the person's highest performance.

Various researchers have developed materials for speech intelligibility in different Indian languages. Abrol (1971) obtained 100% articulation score using Hindi PS words *at 30 dB SL (re:5RT), Kapur (1971) obtained 100% discrimination score at* 45 *dB SL (re:SRT) for Malayalam, lists, Samuel (1976) obtained 100% discrimination score at 35 dB SL (re:SRT) using Tamil words. Mayadevi (1974) obtained the maximum score at 30 dB SL (re:PTA) using English words. Swarnalatha (1972) obtained the same at 33 dB SL (re:SRT) for adults and 36 dB SL (re:SRT) for children using English lists. Ghosh (1988) developed a test of speech intelligibility in Bengali and found the maximum score to be obtained at 30 dB SL (re:SRT). He recommended the test to be administered at 30 dB SL relative to SRT to clinical populations.*

Hence, the review of literature suggests that as the presentation level increases, the speech intelligibility score also increases, but it saturates at some level. Most researchers have found the maximum score at 30-40 *dB SL relative to either SRT or PTA. This is indicative of the fact that, while using the speech materials for intelligibility testing, the clinician should present the stimuli at a suprathreshold level preferably at* 30-40 *dB SL relative to SRT or PTA.*

f. Language background of the scorer

Singh (1966) studied the *influence of the subject's 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,* i.e. *temporal segmentation and filtering. There was a difference in the two groups in recognizing voicing. Native speakers of English responded erroneously more often* than native Hindi speakers on the voicing feature. Results indicated that there was a difference in the perception of the 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 listeners. 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 the same.

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

VII. RESPONSE MODALITY

The response modality needs a serious consideration and would depend upon numerous factors such as age group, literacy, disability of the subjects. There are four basic types of responses that contribute to perception of conversational speech. They are: detection, discrimination, recognition and comprehension (Hirsh, 1966; Boothroyd et al., 1971).

Closed-set response refers *to multiple choice type paradigm and is an example of limited alternative responses availability and can be expected to yield higher scores than an open set (non-limited) procedure. Closed-set tests can over-estimate the speech perception ability and tests such as MRT (House et al. 1963), DFDT (Pang-Chiang and McPherson, 1979), SSI (Speaks and Jerger, 1965), WIPI (Ross and Lerman, 1970), and NU-CHIPS (Katz and Elliott, 1980) impose other physical (i.e. sensory and motor) and linguistic constraints since each reguire adeguate visual acuity and a motoric response of some type. The over-estimation of the scores would be a function of* the number of *pictures per page. In other words, if there are lesser number of alternatives on one page, the chances of the subject getting a correct response is higher and it may lead to overestimation of speech perception abilities.*

Write-down responses, tap linguistic skills. Other factors to be considered are legibility of writing, eye-hand coordination, spelling ability, visual acuity, and the available time (written responses generally reguire more *time). With either talkback or written responses, auditor* errors may *affect speech discrimination scores (Merrel and Atkinson, 1965). Auditory monitoring of patient responses is still widely practiced (Martin and Pennington, 1971; Martin and Forbis, 1978). Written responses have been advocated as a means of eliminating auditor errors (Northern and Battler, 1974).*

A multiple-choice word intelligibility test for adults was developed by Black (1963). Other tests developed in this category, with some modifications, are the Rhyme test by Fairbanks (1958), and the 'vocal communication lab test' by Haagan (1946). The Rhyme Test was designed to emphasize auditory-phonemic factors and to minimize linguistic factors. It somewhat resembles a multiple-choice word test, but instead it is of the completion type.

House et al. (1963) constructed the Modified Rhyme Test. This test had six equivalent lists of 50 words each. The response had to be choosen from an ensemble of six rhyming words. This test, unlike Fairbank's (1958) test, tested for identification of the sound in initial as well as in the final positions.

However, while testing the pediatric population, picture-pointing task has gained wide popularity as it is easier and holds the interest of the subject.

Yathiraj (1987) compared the oral and write-down response modalities anc reported that write-down responses should be preferred whenever possible.

The WIPI test (Ross and Lerman, 1978) uses a closed-set picture-pointing response task for children. It has six foils for each stimulus. The words arc rhyming in nature, NU-CHIPS test (Katz and Elliott, 1980) also has a similar response task, but makes use of four picture foils per stimulus word.

In a study comparing the word discrimination scores of normal-hearing children, Sanderson and Rintlemann (1971) found that higher scores were obtained on WIPI than on PB-K, and that both tests revealed higher scores than the PE words of NU-6. The higher scores in WIPI was attributed to the closed-set response mode as against the open-set mode of PB-K and NU-6.

In summary, several tests of speech identification has been developec for children. These tests differ from the tests developed for adults mainly in terms of the response modality, closed-set, picture-pointing responses are preferred for the pediatric population.

Computerized speech audiometry

The relatively short history of the growth of the computer usage in hearing health care has been an interesting one. When microcomputers burst into the scene at the turn of the 80s, a revolution in audiometric equipment soon followed. What also followed was a tendency to automate each aspect of audiometric test battery.

Early applications of computers to speech audiometry involved simple control over signal presentation level (Wittich et al*., 1971). More recently, development of computer based speech audiometry has progressed in two directions, the use of the computer as a digital tape player and use of the computer for automating adaptive speech audiometric procedures.*

Current speech audiometry instruments represent probably the weakest link in the audiometric chain. Because of a number of problems inherent in the use of analog magnetic tape players, the majority of speech audiometry is still carried out using "live-voice" techniques which is a concept with procedural limitations (Martin and Sides, 1985).

Speech signal can be presented at a pace that is consistent with an individual patient's response time and can be repeated with ease, thus impacting positively on test efficacy. These advantages are especially useful for evaluating children. By using a microcomputer as a digital tape recorder, 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 do not deteriorate over time.*
2. *sophisticated alternations such as time compression, can be made relatively easily.*

3. inter laboratory consistency will improve substantially.

4. *control over stimulus presentation can be enhanced.*

5. stimulus presentation can be easily randomized by the computer.

Another application of computers to speech audiometry is the area of adaptive psychophysical paradigms. Adaptive procedures are growing in popularity because of their increased efficiency in comparison with the conventional approach of presenting word or sentence lists of fixed lengths. Computer now make it possible to automate these adaptive approaches, which should further enhance their population (Stach, 1988).

Some of the speech identification tests those have been recorded on computer include: Early Speech Perception Test (Moog and Geers, 1987).

SUMMARY OF THE REVIEW OF LITERATURE

To summarize, review of the literature indicates that the need for using speech as stimuli for testing hearing was realized more than a century ago. But specially designed tests of speech intelligibility are in regular use for just over fifty years.

Due to *differences in linguistic aspects it is mandatory that tests of speech perception be developed in various languages for adults and the pediatric population.*

While constructing a test of speech perception and various factors must be taken into account (the test must be standardized on a normative population).

I. *The speech materials should be developed in such a way that,it must be appropriate for the target population, i.e. adults* or *pediatric population. Due to the restricted vocabulary in younger children, one must use those words which are present in the target group's vocabulary.*

II. Various stimuli have been used for speech discrimination testing, viz. nonsense syllables, distinctive features, monosyllabic and disyllabic words and sentences. It is evident from the review that the use of monosyllabic words are popular when constructing speech identification tests for children (Carhart, 1965; Ross and Lerman, 1970; Katz and Elliott, 1980). This is because they are less redundant and provide lesser number of cues to the listener for any guess work.

III. The speech stimuli should be developed in such a way that it should be an adequate representation of the phonemic composition of a particular language (Grubb, 1963).

IV. Researchers *vary in their opinion regarding whether a half list is as useful as a full list. The argument in favour of half list is it saves much of clinical time (Elpern, 1961; Campanelli, 1962; Tobias,* 1964*). Whereas, those arguing for full list claim greater accuracy of scores (Grubb, 1963; Martin, 1975). A half list may be used only if the two halves have equal representation of phonemes and difficulty of the test items.*

V. Another important factor is the number of word lists each test should have. Researchers have advocated use of multiple lists which should be phonetically or phonemically balanced. By administering several lists at different intensity levels, the clinician avoids the advantage in scores due to practice effect (Langenbeck, 1965; Tillman et al., 1963; Tillman and Carhart, 1966).

VI. The transmission of the stimuli can be either through recorded tapes or through monitored live voice. Each has its own merits and demerits. But due to greater flexibility and manipulability of the monitored live voice, it would be an ideal method to present the stimuli to the pediatric population.

VII. Researchers have reported of variation in test scores due to the speaker. The speaker's voice quality, pitch, accent, native language and physiological condition contributes to the variation (Treisman, 196b; Hecker, 1974).

VIII. Literature recommends use of carrier phrase with the stimuli. If the carrier phrase ends with a stressed and long vowel, then it facilitates identification of a stimulus word better (Gladstone and Siegenthaler, 1971). But it takes longer time for the test administration (Martin, 1972). Hence, Lynn (1962) advocated a "paired PB-50 discrimination test" in which two stimuli are presented with one carrier phrase. Some other researchers do not find any advantage by using a carrier phrase.

IX. The speech intelligibility test should be performed in a place where there is a good S/N ratio available to the listener. Presence of background noise reduces the performance. However, various speech tests have been devised by incorporating competing noise to find out deficits in the Central Auditory Pathways.

X. Majority of the researchers obtained maximum speech intelligibility scores at a level of 30-40 dB SL relative to SET or PTA. This suggests the fact that speech intelligibility tests should be administered at a suprathreshold level preferably at 40 dfl SL (relative to PTA/SRT) on clinical situations (Tillman, 1963; Ross and Lerman, 1970; Katz and Elliott, 1980; Malini, 1981; Ghosh, 1988).

XI. Finally, the response modality needs a serious consideration. It depends upon numerous factors such as, age group, literacy, disability of the subjects. While testing the pediatric population, picture pointing task has gained wide popularity as it is easier and holds the child's interest (Ross and Lerman, 1970; Elliott and Katz, 1980).

METHODOLOGY

This study was undertaken to develop materials for a test of speech perception for English speaking Indian children and standardize it on the same population.

Subjects

Sixty subjects were taken for the purpose of this study. Ten were tested in the pilot *study and the remaining 50 subjects were tested to obtain the standardized data. All the subjects were selected based on the following criteria:*

1. Age range of six to eight years.

2. Equal number of subjects from both sexes.

3. All subjects had to have English as a medium of instruction for at least one year.

4. Wo *history of any hearing disorder or speech and language delay.*

5. Hearing sensitivity within normal limits (i.e. air conduction threshold of less than or equal to 15 dB HL in the frequency range of 250-8000 Hz in both ears and the air-bone gap less than 10 dB HL at any given frequency.

6. No complaint of any illness on the day of testing.

7. No history of poor academic performance.

Instrumentation

The data was collected using monitored live voice (MLV) on a dual channel clinical audiometer (Madsen OB 822). The output of the audiometer was fed to the earphones (TDH-39) housed in circumaural ear cushions Mx 41-AR.

Calibration of the audiometer was done regularly for pure tones and speech output through the headphones and BC vibrator as prescribed by ISO (1983). Stable power supply to the instrument was ensured by a servo controlled voltage stabilizer.

A block diagram of the instrumentation is depicted in the Figure I.

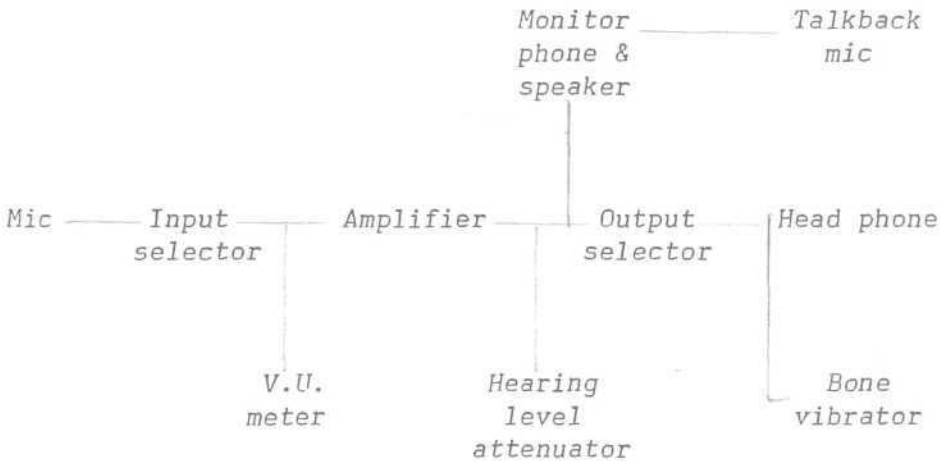


FIG. I: BLOCK DIAGRAM OF SPEECH AUDIOMETER THAT WAS USED IN THE STUDY

Test environment

The data were collected in a sound treated two-room set-up. The ambient noise level in the room was measured as per the recommendations of ISO (1983). The noise level was within permissible limits (Ref: ISO, 1983). The test room was free from any distractors.

Development and standardization of the test materials

The word list used in this study consisted of picturable, monosyllabic, English words commonly occurring within the vocabulary range of Indian children within the age range of six to eight years, studying in English medium schools. The NU-CHIPS test word lists (Elliott and Katz, 1978) served as the main source *test items. The uncommon and less common words in the NU-CHIPS test were deleted, keeping in mind the vocabulary of English speaking Indian children (6-8 years of age). This was done after consultation with experienced primary school teachers, parents and referring to the school textbooks of the target group.*

The deleted words were replaced by more familiar monosyllabic, picturable words retaining the phonemic balance. Twelve more new words were added to the list of 50 words which were to be used as alternative answer choices on the picture plates. These new words, which were picturable, were extracted from the textbooks of the target group. The newly developed lists were subjected to a pilot trial to cross check the familiarity on English speaking Indian children.

Pilot study

Ten subjects (five male and five female) from the target age group (6-8 years) were exposed to the word list individually and asked to identify the words which were not very familiar to them. This was done by asking each child to describe the words in terms of its appearance and/or usage. The subjects were asked the question, "could you please tell me, what is a__________?" A seventy per cent criterion of correct scores was taken as the decisive score for retention of a word. The subjects could identify all of the words.

The newly developed list of 50 words was extracted from the pool of 62 words. Two test forms, each including the same 50 monosyllabic words with different randomization was developed. The two lists were carefully constructed keeping in mind the phonemic balancing for both the inter list and the intralist (half-list). The frequency of all the phonemes was the same as that of NU-CHIPS test (Elliott and Katz, 1978). Also, the first half and second half of the test *was matched in terms of the phonemic representation.*

The *words were picturized and coloured by a professional artist. A picture-response book was developed with four pictures on each plate, out of which one was the correct answer and the other three were alternatives. The four words on each plate were choosen in such a wanner that the alternative choices were as rhyming as possible within the constraints of the 62 words.*

Test materials

The test materials included: two test forms (Appendix I), each including the same 50 monosyllabic words with different randomization; the picture-response book (Appendix II) and the answer sheet format contained the test items of each 'test form' and the *quadrant of the picture foil in which the correct items was located (Quadrant 1 was the picture at the upper left, 2 upper right, 3 lower right and* 4 lower *left). It also contains space for pertinent information about the patient. The picture response book was made in such a way that the same book could be used for both the two test forms, i.e., any given plate contained the two pictures corresponding to its respective serial numbers on the two test forms. It also contained two plates as familiarization items with words that were not used as stimuli.*

The picture book, after its development, was subjected to field testing on the target group to find out the intelligibility of the pictures.

Collection of normative data

The test was administered on each subject at different presentation levels to collect normative data on speech perception. Prior *to this, pure tone thresholds for both air conduction and bone conduction was obtained for the frequencies 250-800 Hz and 250-4OOO Hz respectively. The better ear of each* subject was used as the test ear. The subjects were given the following instructions:

> "You are going to listen to ray voice through the headphones as it we are taking over the telephone. I will be saying some words to you. Listen carefully to each word and look at all the pictures on the page. Point to the picture of the word that you hear. After you point to a picture, the page will be turned for you and I will say the next word. Be sure to listen carefully since some words may be very soft. Take a guess if you are not sure. Do you have any questions ?"

The two items for familiarization were administered to each subject before the start of real testing at a suprathreshold level of 30 dB SL relative to Fletcher Average.

The test was administered on each subject at a suprathreshold level of 12 dB, 18 dB, 24 dB and 30 dB sensation levels (SL) relative to the Fletcher average (the average of the two better thresholds among the speech frequencies: 500 Hz, 1 kHz, 2 kHz) (Ref. Rupp and Stockdell, 1989). The order of the test items was varied for each of the four presentation levels. The two test forms were used once in the order given in the Appendix I and then in the reverse order (Test form I at 12 dB SL, test form II at 18 dB SL, test form I (reverse order) at 24 dB SL and test form II (reverse order) at 30 dB SL). While presenting the stimuli by monitored live voice, utmost care was taken so that the V.U. meter needle deflection was always at 0 dB. A constant distance of 6-9 inches was maintained between the mic and the mouth of the speaker as recommended by Carhart (1965).

The response was recorded on the answer sheet. The error responses were later on subjected to an error analysis on a stimulus-response matrix. The total *score for each test form at the respective presentation levels were calculated by multiplying the correct number of responses by two.*

Statistical analysis

The data collected on the fifty subjects was analyzed using statistical procedures.

An Analysis of Variance (ANOVA) was done to find out the variance in the scores with increase in presentation levels.

T-test was employed to find out the significance of difference between various subgroups, viz. male vs female and six year old vs. seven year old children.

Reliability of the half-list scores was tested by using t-test. Apart from these, mean and standard deviation values for each group of data was calculated to find out the dispersion within a group.

RESULTS AND DISCUSSION

The objective of the present study was to develop test materials for a test of speech perception for pediatric population and to standardize it on the appropriate age group.

I. The data collected on fifty subjects was analyzed so as to obtain the amount of variance with test scores across the presentation levels. This was done with the help of repeated measure ANOVA test (Analysis of Variance) (Gravetter, 1987).

II. The mean and standard deviation were also calculated for each presentation level to find out the dispersion of scores.

III. Reliability of a half-list administration was explored by employing t-test (Growetter, 1987).

IV. The data was also subjected to t-test to find out whether there was any significant difference in the performance of male vs. females.

V. The scores obtained by six year olds and seven year olds was subjected to t-test to find out whether there was any developmental change in the scores.

VI. A cumulative error analysis was done by plotting the stimulus words and responses on a matrix.

I. PERFORMANCE OF SUBJECTS ACROSS PRESENTATION LEVELS (EFFECT OF PRESENTATION LEVEL ON SPEECH INTELLIGIBILITY SCORES)

The two test forms were presented to each subject at four presentation levels, i.e., 12 dB SL, 18 dB SL, 24 dB SL and 30 dB SL (relative to Fletcher

Average (FA) - the average threshold of the two best frequencies within the speech frequencies, i.e. *500 Hz, 1 kHz, 2 kHz). The last two levels being administered for the test forms in the reverse order.*

The mean speech identification scores for all fifty children were 80.84% at 12 dB SL, 89.44% at 18 dB SL, 97.08% at 24 *dB SL and 98.72% at 30 dB SL with standard deviations of 6.18, 4.38, 2.89 and 1.82 respectively (table I).*

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

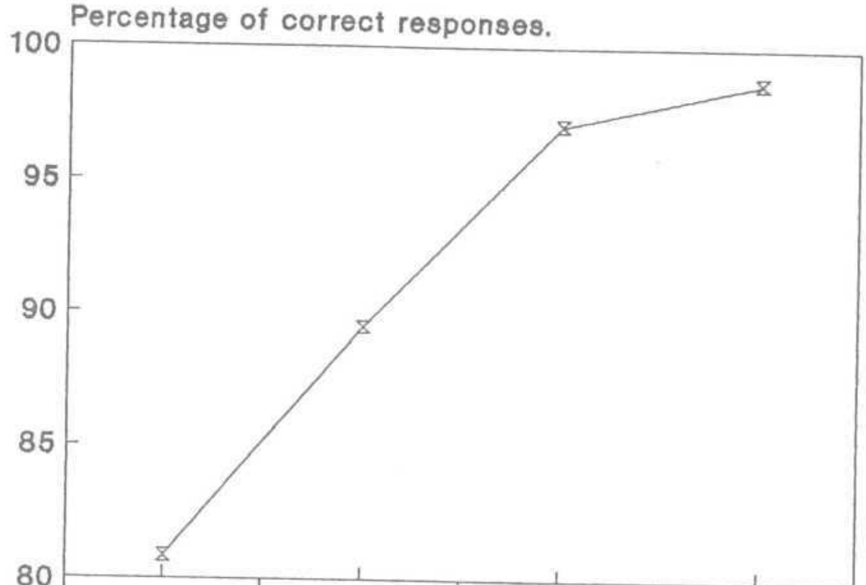
Presentation levels	12 dB SL	18 dB SL	24 dB SL	30 dB SL
Mean (%)	80.84	89.44	97.08	98.72
Standard deviation	6.18	4.38	2.89	1.82

The results of the Analysis of Variance (ANOVA) test revealed a highly significant variance in the mean test scores across the presentation levels (F = 236.59, df = 3, 147, significant at 0.05 level). The table II summarizes the findings of ANOVA (Graveter, 1987).

Table II: Summary of the ANOVA findings

Source	SS	df	MS	F-ratio
Between treatments	10057.1	3	3352.36	
Within treatments	3464.78	196		
* Between subjects	1381.90	49		236.59
* Error	2080.88	147	14.169	
Total	13521.90	199		

Fig.1 : Articulation Curve



	12	18	24	30
Percentage —⧖—	80.84	89.44	97.08	98.72

Presentation Level (dB SL)

The speech perception scores (in percentages) were the greatest at 30 dB SL and lowest at 12 dB SL (relative to F.A.). It showed a steady pattern of increase in performance with increase in presentation level (Table I). This could be due to greater acoustic energy available to the *subjects at higher presentation levels. The above findings is in agreement with Tillman et al. (1963), Carhart (1965), Swarnalatha (1972), Mayadevi (1974), Elliott and Katz (1978) and Malini (1981).*

The shape of the articulation curve is represented in Figure I. The data was not collected for presentation levels below 12 dB SL fRef: *F.A.) as the main interest was to identify at what SLs the normal subjects obtained maximum score. It was found that at 30 dB SL (*Ref: *F.A.) all subjects but one obtained their personal maximum scores.*

Sixteen out of the fifty subjects (32%) scored 100% at 24 *dB SL, whereas 29 of them (58%) got 100% scores at 30 dB SL. The t-test failed to reveal any significant difference in the mean scores at* 24 *dB SL and 30 dB SL (t = 0.82, df* = 48, *not significant at 0.05 level). This indicates that though there was an improvement in scores with increasing intensity, it was not statistically significant. However, the t-test revealed significant differences between the scores obtained at lower SLs,* i.e. *12 dB SL vs 18 dB SL (t -* 4.069, *df* = 48, *significant at 0.05 level) and 18 dB SL vs* 24 *dB SL* ft = 4.321, *df* = 48, *significant at 0.05 level).*

The standard deviation of the scores at each presentation level show an excellent picture of the *dispersion of scores at various levels. With increasing SLs, the standard deviation reduced. At lowest level tested, the standard deviation (S_1) was maximum (6.18) indicating a greater dispersion of scores,* *while at 30 dB SL (ref: F.A.) the standard deviation (5_4) was the least (1.82), reflecting less variance in the scores. At 24 dB SL (ref: F.A.) the 5_3 was also low at 2.89 (Table I). This fact indicates that, as the sensation levels was increased from 12 dB to 30 dB through 18 dB and 24 dB, the scores became more uniform and within a smaller range. At 30 dB SL (ref: F.A.) the scores for forty-nine out of fifty subjects ranged between 96-100%. Whereas, only one subject scored 92%. This could probably be due to the lack of a few stimulus words in the concerned subject's vocabulary. This was further reflected by the fact that the same subject's scores saturated with 92% at 24 dB SL (ref: F.A.).*

As the presentation level of the stimuli was increased, the scores of speech identification improved. However, this performance-intensity trading was saturated at a particular level. In most of the subjects in the present study, the maximum scores (100%) was achieved at 30 dB SL (ref: F.A.).

These findings in this study are in good agreement with other similar studies. Hirsh (1952) found that the maximum intelligibility was reached at 60 dB SPL for the W-22 word lists.

Tillman et al. (1963) found "almost perfect discrimination" was obtained at +24 dB SL for NU Auditory Test No. 4. Tillman and Carhart (1966) obtained an asymptote at 32 dB SL for NU Auditory Test No. 6.

The findings of the present study are also in agreement with other tests of speech intelligibility developed in Indian languages. Abrol (1971) obtained 100% articulation score using Hindi PB words at 30 dB SL (ref: SRT), Kapur (1971) obtained 100% discrimination scores at 45 dB SL (ref: SRT) for Malayalam lists, Samuel (1976) obtained 100% discrimination scores at 35 dB SL (ref: PTA) using English words. Swarnalatha (1972) obtained the same at 33 dB SL (ref: SRT) for adults and 36 dB SL (ref: SRT) for children using English lists. Ghosh (1988) developed a test of speech perception in Bengali and found the asymptote score to be obtained at 30 dB SL (ref: SRT).

Based on the findings of the present study and that of other investigators, it seems appropriate to administer this test on clinical population at a suprathreshold level, preferably 30-40 dB SL relative to the Fletcher Average to generate the subject's maximum response.

II. RELIABILITY OF HALF-LIST ADMINISTRATION

The main purpose of constructing two 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 also be useful while testing children whose attention span is not long enough to carry out the entire test. Many researchers have recommended the idea of using a half-list for evaluating speech intelligibility (Carhart, 1965; Elpern, 1961; Elliott and Katz, 1980).

Table III: Mean and standard deviation scores for the two half-lists at 12 dB SL

	First half	Second half
Mean	41.3	41.9
Standard deviation	2.18	2.63

The table III shows the mean scores obtained by the fifty subjects on the first half and second half of the test form I at 12 dB SL (ref: F.A.). The data was subjected to t-test. Results indicate that the t-value did not fall within the critical value. In other words, there was no significant difference *between the two half lists at a particular presentation level (t = -0.1, df =* 49, *not significant at 0.05 level).*

An ideal test form should have both the half lists yielding similar results. The present word list under study also revealed the same characteristic features. This fact justifies the process of phonemic balancing and familiarity rating employed while developing the lists. The statistical analysis reveal that one can administer the half list and get similar test results as that of a full list administration.

However, the error analysis showed that there are few stimuli which were consistently misperceived than other.

III. ERROR ANALYSIS

The stimuli and the corresponding responses for each subject were plotted on a stimulus-response matrix. The stimuli were represented in the vertical axis, whereas, the *responses on the horizontal axis.*

Analysis of the errors revealed that most of the *confusion occurred for minimal contrast words (eg. 'mug' and 'jug'); those words which share common syllabic nucleus or ended with a common vowel. Some other errors were consistently seen across many subjects due to the ambiguity in the pictures utilized within a plate (e.g. 'head' and 'hair').*

The error analysis was done for two extreme presentation levels, i.e. 12 dB 5L and 30 dB SL. The error pattern was more scattered at the lower level whereas, with the increase in intensity level, the number of errors decreased. An important observation was that the errors due to the ambiguity of pictures continued to persist even with the *increase in presentation level. On the other* hand, errors due to auditory confusion of the stimuli tended to decrease with increase in intensity. This points to the fact that higher intensity level facilitated the identification task in a closed-set consisting of similar sounding alternative items on a picture plate. Furthermore, when the error was due to the difficulty in recognizing the picture (as in case of 'head' and 'hair') even an increase in presentation level did not help improve the scores.

When the error analysis was done across both the half lists, it was found that there were some items on both sides which consistently yielded lower scores even at higher presentation levels, eg. 'jug', 'head', 'hair' and 'drink' in the first half and 'frog', 'truck', 'milk' and 'mug' in the second half were the items which yielded poor scores on both list I and II. The stimulus items 'head', 'hair' and 'milk' were most probably misperceived due to the ambiguity in the test pictures. Whereas, the scores for the words 'truck', 'duck' and 'frog' lied on the borderline range of criterion. Finally, the stimulus items 'jug' and 'mug' were confused due to the minimal contrastive nature. At least 75% of the subjects responded correctly when each stimulus item was analyzed.

IV. EFFECT OF GENDER ON THE SPEECH INTELLIGIBILITY SCORES

This study included egual number of subjects from both sexes, i.e., 25 male and 25 female subjects were studied. The male subjects obtained a mean score of 80.72% at 12 dB SL (ref: F.A.) with a standard deviation of 6.19. The female subjects also obtained similar scores with a mean of 80.96% at the same intensity level with a standard deviation of 4.70.

Table IV: Mean and standard deviation scores of male and female subjects (12 dB SL, relative to F.A.)

	Male	Female
Mean	80.72%	80.95%
Standard deviation	6.19	4.70

The data was subjected to t-test and there was no significant differences between the mean scores obtained by the male and female subjects ($t = -0.219$, $df = 48$, $p < 0.05$)

The statistical information revealed that the test was equally difficult or equally easy to both groups. This finding is in agreement with the literature (Ross and Lerman, 1970; Elliott and Katz, 1978; Jerger and Jerger, 1980).

V. EFFECT OF AGE ON THE SPEECH INTELLIGIBILITY SCORES

Various researchers have demonstrated an age-related difference in the performance in speech intelligibility scores (Katz and Elliott, 1978; Siegenthaler and Haspiel, 1966; Ross and Lerman, 1970). As the age increases, the speech intelligibility score improves. This however depends on various factors, viz. age group of the subjects, familiarity and difficulty of level of materials, etc.

In the present study, the subjects were divided into two groups of 6-7 year and 7-8 year olds to find out whether there was any developmental change seen. The younger age group consisted of 23 subjects and the older group consisted of 27 subjects. At 12 dB SL (ref: F.A.) the younger group of subjects obtained a mean score of 79.91% whereas the older group obtained a mean score of 81.63%.

Table V: Mean and standard deviation scores of the two age groups at 12 dB SL (ref: F.A.)

	6-7 years	7~8 years
Mean	79.91%	81.63%
Standard deviation	3.49	3.01

The data thus obtained at 12 dB SL was subjected to t-statistics to find out whether there was any significant difference in the mean score *obtained between the two groups. Results revealed that there was no significant difference between the mean scores obtained by the subjects within the age groups 6-7 years and 7-8 years (t =1.07, df* = 48, p < *0.05).*

The insignificance in the difference of scores between the two age groups reveal that younger children are able to perform almost on par with the older group. This occurred as the word list was chosen from the test books of the younger group subjects. Hence it was not significantly difficult for the two groups.

The statistical analysis was done only at one presentation level, i.e. the lowest level because, it is at the lowest level, where maximum errors were seen *and the scores* were more scattered. Whereas, *at 30 dB SL* (ref: *FA) the scores were not so variant.*

In conclusion, the finding of the present study are:

1. With increase in intensity of presentation level, the subjects' performance improved.

2. Majority of the subjects obtained their maximum scores at 30 dB SL (ref: F.A.).

3. The test can be administered at a suprathreshold level of 30-40 dB SL in clinical use.

4. *A half-list can be administered to save clinical time without jeopardizing the accuracy of scores.*

SUMMARY AND CONCLUSION

This study aimed at developing and standardizing monosyllabic word lists which required a *picture-pointing response as a test of speech perception for Indian children.*

The following null hypotheses were putforth in the study:

I. There is no significant difference between the mean scores obtained by the subjects at different present-ation levels, i.e. *12 dB SL, 18 dB SL,* 24 *dB SL and 30 dB SL relative to Fletcher Average.*

II. There is no significant difference between the performance of girls and boys on the same test.

III. There is no difference between the performance of the subjects on the first half and second half of the test forms.

IV. There is no difference between the age of the subjects and the performance of the test.

Fifty normal hearing subjects (25 girls and 25 boys) within the age range of 6-8 years were selected for the study. The subjects had to fulfil the following fixed criteria:

1. *Age range of 6-8 years.*
2. *Equal number of subjects from both sexes.*
3. *All subjects had to have English as a medium of instruction for at least one year.*
4. No history *of any hearing disorder or speech and language problem.*
5. *Their hearing sensitivity had to be within normal limits (i.e. air conduction threshold less than or equal to 15 dB HL in the frequency range of*

250-8000 Hz in both ears and the air bone gap less than 10 dB HL at any given frequency).

6. No history of poor academic performance.

7. No illness on the day of testing.

The subjects were selected from a wide variety of background for data collection. Pure tone audiometry (both A.C. and B.C.) was done for each subject to rule out any hearing problem.

Results of the study

All the hypotheses were accepted except for hypothesis I.

I. When the test was administered to the same subject group at different intensity levels, a significant improvement in scores was noticed as the presentation level increased. This is primarily attributed to the greater acoustic energy available to the listener at a higher intensity.

II. All the subjects obtained their personal best scores at 30 dB 5L relative to the Fletcher Average. This finding is in agreement with the previous works reported in the literature (Ross and Lerman, 1970; Katz and Elliott, 1978; Malini, 1981).

III. The two half-lists of the main test form proved to be equally difficult to the same subject group. When t-test was administered, no significant difference was obtained between the mean scores on the two halves. The two half lists were phonemically balanced and represented the frequency of occurrence of phonemes in the original test form.

IV. An error analysis with the help of a stimulus response matrix revealed that most of the errors were of minimal contrast in nature (eg. 'mug' *and 'jug'); or shared a similar syllabic nucleus (eg.* tree *and drink). Some other errors were consistently seen across many subjects due to confusion in identifying pictures, eg. 'head' and 'hair'.*

V. The scores obtained by male and female subjects were compared. There was no significant difference between the scores of the two groups. In other words, both groups performed egually well in the test. Hence the same set of normative data holds good for both the groups.

VI. Though various researchers have demonstrated an age related difference in the performance in the speech intelligibility scores (Katz and Elliott, 1978; Siegenthaler and Haspiel, 1966), the present study did not reveal any difference in the test scores across' the age groups. This is attributed to the fact that the age range in this study was very narrow (i.e. 6-8 years) and the words taken for this study were from the text books of the lower age group (6-7 years).

From the findings of the present study, the following recommendations are made for the test of speech perception standardized on the Indian population.

a. It can be administered for children above 6 years of age who have at least one year of exposure to English.

b. To obtain the best speech perception scores, the test should be administered at 30-4O dB SL (ref: Fletcher Average).

c. For those children with a *smaller attention span, one of the half-lists can be administered reliably.*

d. Before administering the test list, it is essential to familiarize the subject using the familiariza-tion items given at the beginning of the picture response book.

e. *The same test y be used with adult subjects who have inadequate speech and/or language skills after obtaining normative data.*

f. The developed material can also be used for the pediatric population while selecting amplification devices.

8. The developed test materials are further recommended as an excellent tool for monitoring progress of an auditory training program. The results at regular intervals using the different forms can be noted.

RECOMMENDATIONS FOR FURTHER RESEARCH

Using the test material developed in the present study it is recommended that further research be carried out. The following are the few research directions that can be taken into consideration:

I. To standardize the same test on a wider age range of subjects including adults.

II. To standardize the test on deviant populations such as: hearing impaired, learning disabled, childhood aphasics and mentally retarded subjects.

III. To compare the performance of deviant populations with age and language matched normal population. This would give a better insight into the understanding of the speech perception in deviant population.

IV. To compare the performance of cochlear implant users vs. hearing *aid users.*

V. To study the performance of subjects with varying degrees of hearing loss.

VI. The test stimuli can be presented with a competing noise to stress the auditory system and results be compared with no-noise conditions.

REFERENCES

Alpin, D.Y. and Kane, J.M. (1985): Variables affecting pure tone and speech audiometry in experimentally simulated hearing loss. British Journal of Audiology, 19, 219-228.

Alusi, H.A., Hinchcliffe, R., Ingham, B., Knight, J.J. and Northm, C. (197k): Arabic Speech Audiometry, Audiology, 13, 212-220.

American National Standards Institute (1969): American National Standards Specification for Audiometers. ANSI S3-6-1969, New York.

Asher, J.W. (1958): Intelligibility tests: A review of their standardization, some experiments, and a new test. Speech Monographs, 25, 24-28.

Ashoor, A.A.and Prochazka, T. (1982): Saudi Arabic Speech Audiometry. Audiology, 21, 493-508.

Ashoor, A.A.and Prochazka, T. (1985): Saudi Arabic Speech Audiometry in Children. British Journal of Audiology, 19, 229-238.

Beattle, R.C., Svihovee, D.V. and Edgerton, B.J. (1975): Relative intelligibility of the CID spondees as presented via monitored live voice. Journal of Speech and Hearing Disorders, 40, 84-91.

Berger, K.W. (1969): A speech discrimination task using multiple choice key words in sentences. Journal of Auditory Research, 3, 247-262.

Berger, K.W. (1971): Speech Audiometry. In D.E. Rose (Ed.), Audiological Assessment. New Jersy: Prentice-Hall, Inc.

Berger, K.W., Keating, L.W. and Rose, D.E. (1971): An evaluation of the Kent State University (KSU) speech discrimination test on subjects with SN loss. Journal of Auditory Research, 11, 2, 240-143.

Bess, F.H. (1982): Basic Hearing Measurement. In N.J. Lass, L.V. McReynolds, J.L. Northern, and D.E. Yoder (Eds.), Speech, Language and Hearing. Philadelphia: W.B. Saunders Co.

Bess, F.H. (1983): Clinical assessment of speech recognition. In D.F. Konkle and W.F. Rintlemann (Eds.), Principles of Speech Audiometry. Baltimore: University Park Press.

Beykirch, H.L. and Gaeth, J.H. (1978): A comparison of speech discrimination scores by using PB-50 lists and the speech discrimination scale with hearing impaired adults. Journal of Auditory Research, 18, 3, 153-164.

Black, J.W. (1952): Accompaniments of word intelligibility. Journal of Speech and Hearing Disorders, 17, 409-418.

Bode, D. and Carhart, R. (1973): Measurement of articulation functions using adaptive test procedures. IEEE Transactions on Audio and Electro-acoustics, AU 21, 196-201.

Boothroyd, A. (1968): Developments in Speech Audiometry. Sound, 2, 3,-10.

Brady, P.T. (1971): The need for standardization in the measurement of speech level. Journal of the Acoustic Society of America, 50, 712-714.

Brinkmann, K. (1987): The German path to standardization in speech audiometry. In Martin, M. (Ed.) Speech Audiometry, London: Whurr Publishers Ltd.

Carhart, R. (1965): Problems in the measurement of speech discrimination. Archives of Otolaryngology, 82,253-260.

Danhauer, J.L., Crawford, S. and Edgerton, B.J. (1984): English, Spanish and Bilingual speakers' performance on a Nonsense Syllable Test (NST) of speech and discrimination. Journal of Speech and Hearing Disorders, 49, 164-169.

Danhauer, J.L., Johnson, C. and Asp, C.W. (1984): Hearing impaired children's performance on the Edgerton and Danhauer Nonsense Syllable Test. Journal of Auditory Research, 24, 4, 231-238.

Danhauer, J.L., Lewis, A. and Edgerton, B. (1985): Normally hearing children's responses to a nonsense syllable test. Journal of Speech and Hearing Disorders, 50, 1, 100-104.

Davis, H. and Silverman, R.S. (1978): Hearing and Deafness. 4th Ed., New York: Holt Rinehart and Winston.

Deutsch, L.J. and Kruger, S. (1971): The systematic selection of 25 monosyllables which predict the CID-22 speech discrimination score. Journal of Auditory Research, 11, 3, 286-290.

Devaraj, A. (1983): Effect of word familiarity on speech discrimination score. Unpublished Masters Dissertation, University of Mysore, Mysore.

Dillon, H. (1982): A quantitative examination of the sources of speech discrimination test score variability. Ear and Hearing, 3, 51-58.

Dillon, H. (1983): The effect of test difficulty on the sensitivity of speech discrimination tests. Journal of the Acoustical Society of America, 73, 336-344.

Dirks, D.D., Damm, C., Bower, D. and Betsworth, A. (1977): Use of performance-intensity functions for diagnosis. Journal of Speech and Hearing Disorders, 47, 114-123.

Edgerton, B.J. and Danhauer, J.L. (1979). Clinical implica-tions of speech discrimination testing using nonsense stimuli. Baltimore: University Park Press.

Egan, J.P. (1948): Articulation testing methods. Laryngoscope 58, 955-991.

Elizabeth, (1983): The effect of training and native language on scoring the *responses on a speech discrimination test in English. Unpublished Masters Dissertation, University of Mysore, India.*

Elliot, L.L., Clifton, L.B. and Servi, D.G. (1983): Word frequency effects for a closed-set word Identification Test. Audiology, 22, 229-240.

Elliott, L. and Katz, D. (1980): Development of a New Children's Test of speech Discrimination. Auditec of St. Louis.

Elliott, L., Conners, S., Kille, E., Levin, S., Ball, K. and Katz, D. (1979): Children's understanding of mono-syllabic nouns in quiet and in noise. Journal of the Acoustical Society of America, 66, 12-21.

Erber, N.P. (1974): Pure tone thresholds and word recognition abilities of hearing impaired children. Journal of Speech and Hearing Research, 17, 194-202.

Erber, N.P. (1977): Evaluating speech perception ability in hearing impaired children. In F.H. Bess (Ed.) Childhood Deafness: Causation, Assessment and Management. New York: Grune and Stratton.

Erber,' N.P. (1980): Use of auditory numbers test to evaluate speech perception abilities of hearing impaired children. Journal of Speech and Hearing Disorders, 45, *527-532.*

Erber, N.P. (1980): Use of the auditory numbers test to evaluate speech perception abilities of hearing impaired children. Journal of Speech and Hearing Disorders, 41, *256-267.*

Fairbanks, G. (1958): Test of phonemic differentiation: The Rhyme Test. Journal of the Acoustical Society of America, 30, 596-600.

Finitzo-Heiber, T., Gerli, 1.3.. Matkin, N.D. and Cherow-skalka, E. (1980): A sound effects recognition test for paediatric evaluation. Ear and Hearing, 1, 271-276.

Fourcin, A.J. (1976): Speech pattern tests for deaf children. In Stephens, S.D.G. (Ed.). Disorders of Audiology Function, II. London: Academic Press.

French, N.R. and Steinberg, J.C. (1947). Factors governing the *intelligibility of speech sounds. Journal of the Acoustical Society of America, 19, 90-119.*

Geffner, D. and Donovan, N. (1974): Intelligibility functions of normal and sensorineural loss subjects on VJ-22 lists. Journal of Auditory Research, 24, *1, 82-88.*

Gelfand, *S.A. (1975): Use of carrier phrase in live voice speech discrimination testing. Journal of Auditory Research, 15, 107-110.*

Gengel, R.W. (1973): On reliability of discrimination performance in persons with SN hearing impairment using a closed-set test. Journal of Auditory Research, 13, 2, 97-100.

Gladstone, V.A. and Siegenthaler, B.M. (1971): Carrier phrase and speech intelligibility test score. Journal of Auditory Research, 11, 101-103.

Gravetter, F.J. and Wallnau, L.B. (1987). Statistics for the behavioural sciences. New Delhi: Tata McGraw-Hill Publishing Co. Ltd.

Grubb, P. (1963): A phonemic analysis of half-list speech discrimination tests. Journal of speech and Hearing Research, 6, 3, 271-275.

Hagerman, B. (1976): Reliability of the determination of speech discrimination. Scandinavian Audiology, 5, 219-228.

Harris, J.D. (1965): Speech audiometry. In Glorig, A. (Ed.), Audiometry. Baltimore:The Williams and Wilkins Company, pp. 151-152.

Hirsh, I.J. (1952): The measurement of hearing. New York: McGraw-Hill.

Hirsh, I.J., Davis, H., Silverman, S.R., Reynolds, E.G., Eldert, E. and Benson, R.W. (1952): Development of materials for speech audiometry. Journal of Speech and Hearing Disorders, 17, 321-337.

Hirsh, I.J., Reynolds, E.G. and Joseph, M. (1954): Intelligibility of different speech materials. Journal of the Acoustical Society of America, 26, 530-538.

Hood, J.D. (1981): Speech Audiometry. In Beagley, H.A., Audiology and Audiological Medicine, Volume 1, Oxford: Oxford University Press.

Hood, J.D. and Poole, J.P. (1977): Improving the reliability of speech audiometry. British Journal of Audiology, 11, 93-102.

Jerger, J., Speaks, C. and Trammell, J.L. (1968): A new approach to speech audiometry. Journal of Speech and Hearing Disorders, 33, 318-328.

Jerger, J. and Jerger, S. (1971): Diagnostic significance of PB words functions. Archives of Otolaryngology, 93, 573-580.

Jerger, J. (1980): Paediatric speech intelligibility test. I. Generation of test materials. International Journal of Paediatric Otorhinolaryngology, 2, 217-230.

Jerger, S. and Jerger, J. (1976): Estimating speech thresholds from the PI-PB function. Archives of Otolaryngology, 102, 487-496.

Jerger, S. and Jerger, J. *(1984): Paediatric speech intelligibility test. Auditec of St. Louis.*

Jerger, S. and Jerger,J. (1982): Paediatric Speech Intelligi-bility Test: Performance-Intensity Characteristics. Ear and Hearing, 3-6, 325-334.

Jerger, S., Jerger, J. and Abrams, S. *(1983): Speech audiometry in the young child. Ear and Hearing, 4, 56-66.*

Jerger, *5., Jerger, J. and Lewis, S. (1981): Paediatric speech intelligibility test. II. Effects of receptive language and chronological age. International Journal of Paediatric Otorhinolaryngology, 3, 110-118.*

Jerger, S., Lewis, S., Hawkins, J. and Berger, J. (1980): Pediatric speech intelligibility test: Generation of test materials. International Journal of Pediatric Otorhinolaryngology, 2, 217-230.

Kapur, Y.P. (1971): Needs of the speech and hearing handicapped in India. Cited in Martin, M. (Ed.), Speech Audiometry. London: Whurr Publication.

Kasden, S.D. (1970): Speech discrimination in two age groups matched for hearing loss. Journal of Auditory Research. 10, 3, 210-212.

Katz, D.R., Elliott, L.L. (1978). Development of a new children's speech discrimination test. Presented in American Speech-Language-Hearing Association, Chicago.

Kruel, E.J., Bell, D.W. and Nixon, J.C. (1969): Factors affecting speech discrimination test difficulty. Journal of Speech and Hearing Research, 12, 281-287.

Kruel, E.J., Nixon, J.C, Kryter, K.D., Bell, D.W. and Lang, J.S. (1968): A proposed clinical test of speech discrimination. Journal of Speech and Hearing Research, 11, 536-552.

Kryter, K.D., Williams, C. and Green, D.M. (1962): Auditory acuity and the perception of speech. Journal of the Acoustical Society of America, 34, *1217-1223.*

Ladefoged, P. (1982): A course in phonemics (2nd Ed.), New York: Harcopurt Brace Jovanovich.

Larson, G.W., Peterson, B. and Jacguot, W.S. (197k): Use of North-Western University Auditory test No. 6 for speech discrimination testing with children. Journal of Auditory Research, 14, 4, *286-292.*

Lehiste, I. *and Peterson, G.E. (1959): Linguistic consider-ations in the study of speech intelligibility. Journal of the Acoustical Society of America, 31, 280-286.*

Lerman, J.W., Ross, M. and McLauchlin, R.M. (1965): A picture identification test for hearing-impaired children. Journal of Audiological Research, 5, 273-286.

Lowell, E.L. (1974): Auditory and visual perception of different units of speech. Scandinavian Audiology, Supplement. 4, 32-37.

Lynn, J.M. and Brotman, S.R. (1981): Perceptual significance of the CID-W22 carrier phrase. Ear and Hearing, 2, 95-99.

Mackie, K. and Dermody, P. (1986): Use of a monosyllabic adaptive speech test (MAST) with young children. Journal of Speech and Hearing Research, 29, 275-281.

Malini, M.S. (1981): Standardization of NU auditory test no. 6. on *an English speaking Indian population. Unpublished Masters Dissertation, University of Mysore, India.*

Markides, A. (1978): Speech discrimination functions for normal hearing subjects with AB isophonemic word lists. Scandinavian Audiology, 7, 239-245.

Markides, A. (1987): Speech tests of hearing for children. In Martin, M. (Ed.), Speech Audiometry, London: Whurr Publishers Ltd.

Martin, F. and Sides, D. (1985): Survey of current audiometric practices. ASHA, 2, 29-36.

Martin, F.N., Hawkins, R.R. *and Bailey, H.A.T. (1962): The nonessentiality of the carrier phrase in phonetically balanced (PB) word testing. Journal of Auditory Research, 2, 319-322.*

Mayadevi, G. (1974): Development and stardardization of a common speech discrimination test for Indians. Unpublished Masters Dissertation, University of Mysore, India.

McPherson, D.F. and Pang-Chiang, G.K. (1979): Development of a distinctive feature discrimination test. Journal of Auditory Research, 19, 4, 235-246.

Olsen, VI.0. and Matkin, N.D. (1979): Speach audiometry. In Rintlemann, W.F. (Ed.), Hearing Assessment. Baltimore: University Park Press.

Owens, E. (1961): Intelligibility of words varying in familiarity. Journal of Speech and Hearing Research, 4, *113-129.*

Owens, E. and Schubert, E.D. (1968): The development of California consonant test. Journal of Speech and Hearing Research, 20, 463-474.

Owens, E., Kessler, D.K., Talleen, C.C. and Schubert, E.D. (1980): The Minimal Auditory Capabilities Battery. Auditec of St. Louis.

Peterson, G.E. and Lehiste, I. (1962): Revised CNC lists for auditory tests. Journal of Speech and Hearing Disorders, 27, 62-70.

Plant, G. and Westcott, S. (1982): A diagnostic speech perception test for severely and profoundly hearing impaired children. Australian Journal of Audiology, Supplement, 1, 9.

Priede, V.M. and Coles, R.R.A. (1976): Speech discrimination tests in investigation of sensorineural hearing loss. Journal of Laryngology and Otology, 90, 1081-1092.

Pronovost, W. and Dumbleton, C. (1954): A picture type speech sound discrimination test for children. Journal of Speech and Hearing Research, 19, 360-366.

Ross, M. and Lerman, J.W. (1970): A picture identification test for hearing impaired children. Journal of Speech and Hearing Research, 13, 44-53.

Rupp, R.R. and Stockdell, K.G. (1980): The roles of speech protocols in audiology. In Rupp, R.R. and Stockdell, K.G. (Eds.), Speech Protocols in Audiology, New York: Grune and Stratton, Inc.

Savin, H.B. (1963): Word frequency effects and errors in the perception of speech. Journal of the Acoustical Society of America, 35. 200-206.

Siegenthaler, B. and Hospiel, G. (1966). Development of two standardized measures of hearing for speech by children. U.S. Department of Health, Education, and Welfare, Project No. 2372, Contract No. OE-5-10-003.

Silverman, S.R. and Hirsh, I. (1955): Problems related to the use of speech in clinical audiometry. Annals of Otology, Rhinology and Laryngology, 64, 1234-1244.

Smith, K.E. and Hodgson, W.R. (1970): The effects of systematic reinforcement on the speech discrimination responses of normal and hearing impaired children. Journal of Auditory Research, 10, 2, 110-117.

Stach, B.A. (1988): Computers and audiologic instrumentation. Hearing instruments, 39, 8, 13-16.

Stockdell, K.G. (1980): Classical approaches to measuring discrimination efficiency via word lists. In Rupp, R.R. and Stockdell, K.G. (Eds.), Speech Protocols in Audiology, New York: Grune and Stratton, Inc.

Swarnalatha, K.C. (1972): The development and standard-ization of speech test materials in English for Indians. Unpublished Masters Dissertation, University of Mysore, India.

Tillman, T,W., Carhart, R. and Wilber, L. (1963): A test of speech discrimination composed of CISC monosyllabic words. North-Western University Auditory Test No. 4. Technical Documentary Report No. SAM-TDR-62-135, USAF School of Aerospace Medicine, Brooks Air force Base, Texas.

Urbantschitsch, V. (1895): Auditory training for deafmutism and for deafness acquired in later life. Cited in Martin, M. (Ed.), Speech Audiometry. London, Whurr Publishers Ltd., pp. 155-156.

Weber, S. and Redell, R.C. (1975): A sentence test for measuring speech discrimination in children. Audiology, Hearing and Education, 2, 25-30.

Wittich, W.W., Wood, T.J. and Mahaffey, R.B. (1971): Computerised Speech Audiometry. Journal of Auditory Research, 11, 335-344.

Wolf, 0. (1874): New investigative methods of examination and derangement of hearing. Cited in O'Neill, J.J. and Oyer, H.J. (1966): Applied Audiometry. New York, Dodd, Mead and Company, Inc., pp. 76-77.

Zubick et al. (1983): Development of Speech Audiometric Materials for native Spanish adults. Audiology, 22, 1, 8-10.

PERCEPTION OF MONOSYLLABIC WORDS
IN INDIAN CHILDREN (ENGLISH)

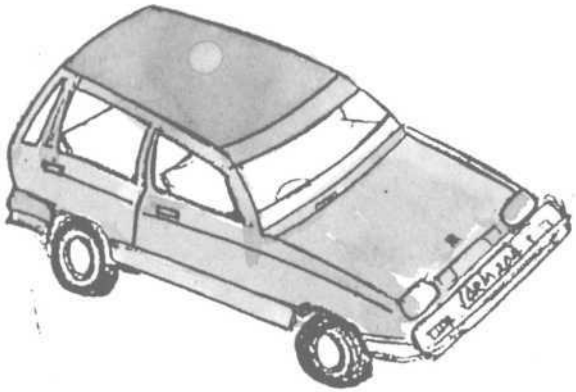
APPENDIX - I

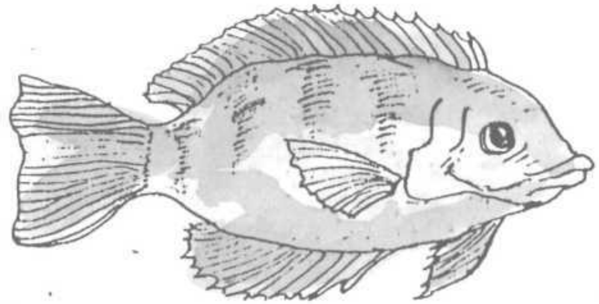
Name: Age/Sex:
Identity #: Date:
Tester:
Puretone Thresholds:

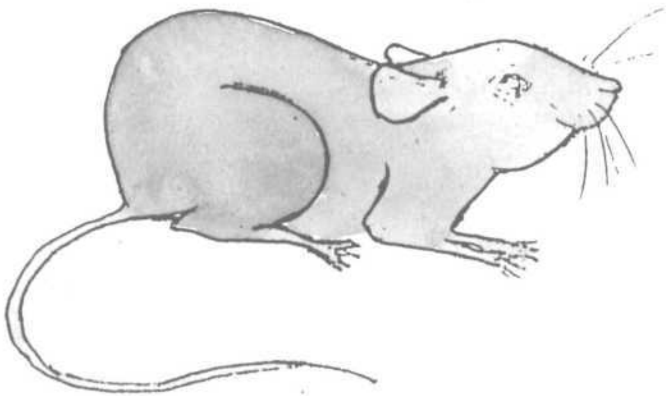
Freq(Hz)	250	500	1000	2000	4000	8000
Thre.						

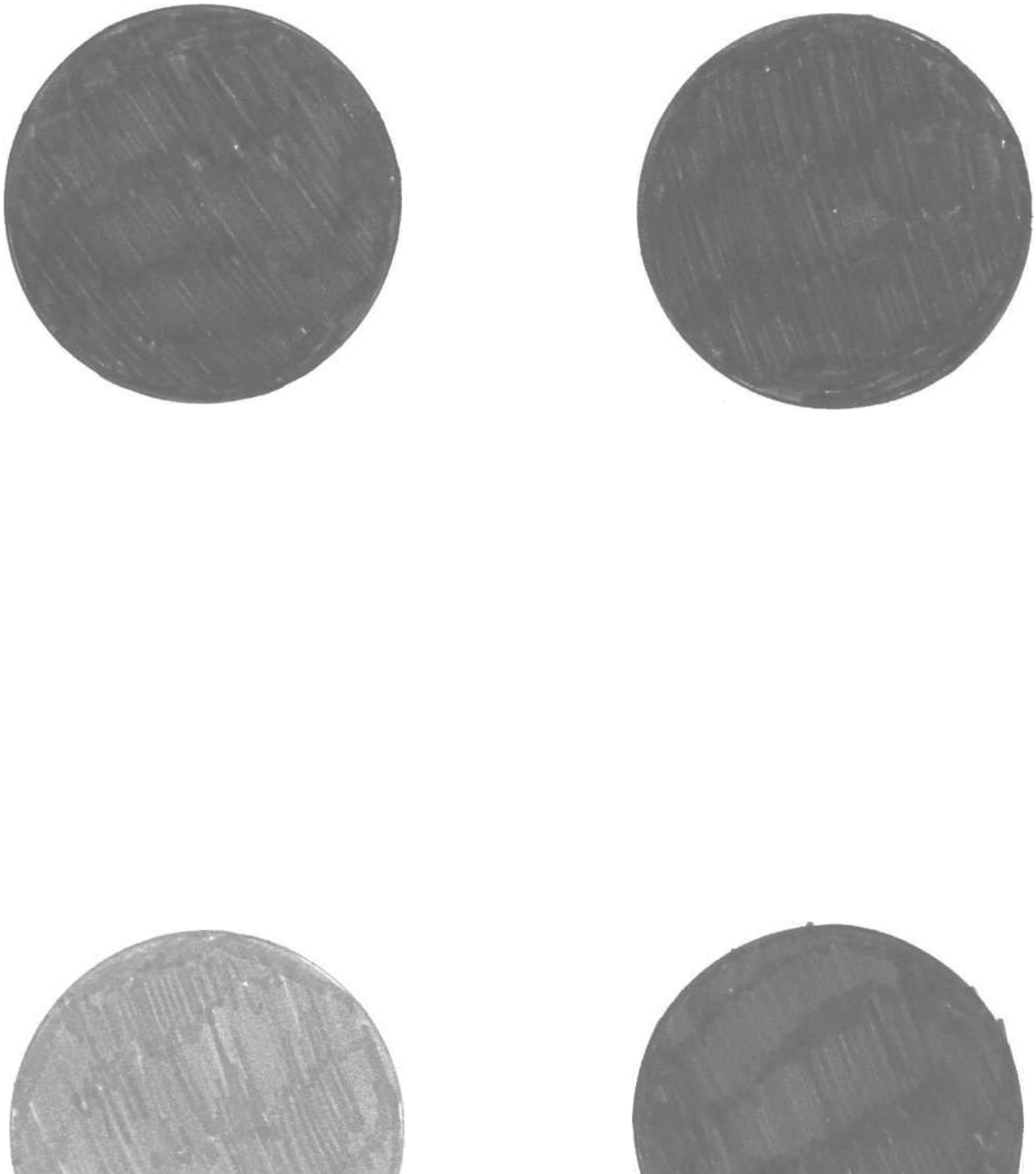
Test form 1		Test form 2	
---- dB SL (ref FA)		---- dB SL (ref FA)	
____ %		---- %	
1. Dog (1)		1. Tongue (3)	
2. Purse (1)		2. Horse (4)	
3. Milk (3)		3. Mug (2)	
4. Nose (4)		4. Goat (1)	
5. Hand (3)		5. Fan (4)	
6. Watch (2)		6. House (2)	
7. Foot (3)		7. Pant (4)	
8. Truck (4)		8. Cap (1)	
9. School (1)		9. Spoon (3)	
10. Door (1)		10. Shoe (4)	
11. House (2)		11. Watch (1)	
12. Teeth (4)		12. Sleep (2)	
13. Lock (3)		13. Duck (4)	
14. Bus (2)		14. Gun (3)	
15. Mug (4)		15. Milk (2)	
16. Fan (4)		16. Hand (3)	
17. Bird (4)		17. Shirt (2)	
18. Sleep (3)		18. Teeth (1)	
19. Cap (2)		19. Truck (4)	
20. Shirt (3)		20. Bird (1)	
21. Pant (2)		21. Foot (3)	
22. Gun (3)		22. Bus (4)	
23. Tongue (4)		23. Frog (3)	
24. Goat (1)		24. Nose (4)	
25. Bed (1)		25. Bat (3)	
26. Frog (3)		26. Dog (1)	
27. Horse (2)		27. Purse (4)	
28. Drink (1)		28. Tree (2)	
29. Boat (1)		29. Soap (3)	
30. Head (4)		30. Hair (1)	
31. Wash (1)		31. Dress (2)	
32. Shoe (4)		32. Door (3)	
33. Duck (3)		33. Lock (1)	
34. Spoon (3)		34. School (4)	
35. Hair (1)		35. Head (3)	
36. Snake (4)		36. Clock (2)	
37. Tree (3)		37. Drink (4)	
38. Clock (3)		38. Snake (2)	
39. Dress (2)		39. Wash (1)	
40. Jug (1)		40. Cup (2)	
41. Man (2)		41. Pen (3)	
42. Leaf (4)		42. Leaf (4)	
43. Cup (2)		43. Jug (1)	
44. Girl (2)		44. Ball (1)	
45. Bat (1)		45. Bed (4)	
46. Pen (2)		46. Man (3)	
47. Train (2)		47. Train (2)	
48. Comb (4)		48. Comb (4)	
49. Soap (4)		49. Boat (3)	
50. Ball (3)		50. Girl (2)	

FAMILIARIZATION ITEMS

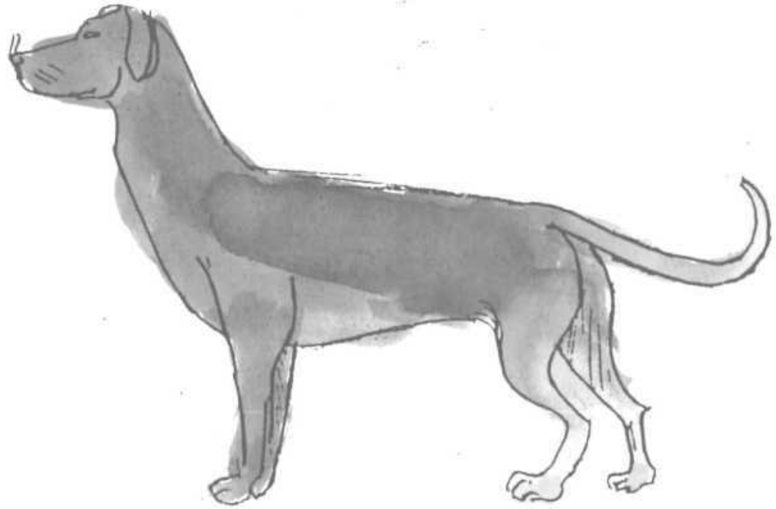




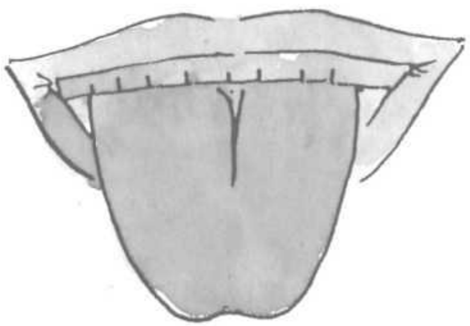


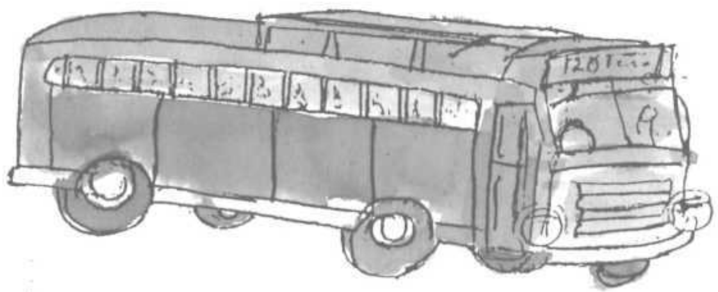


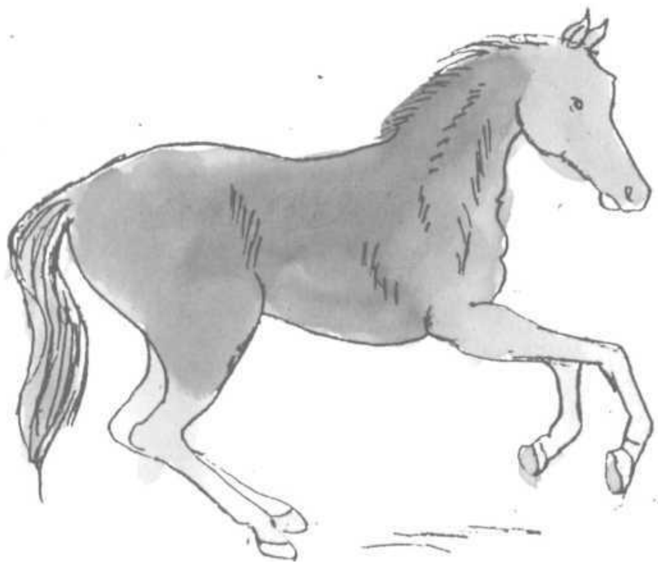
TEST ITEMS

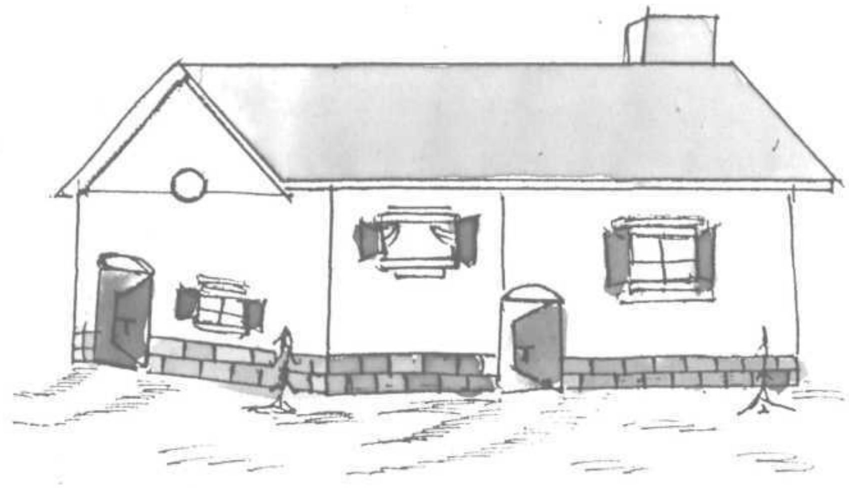


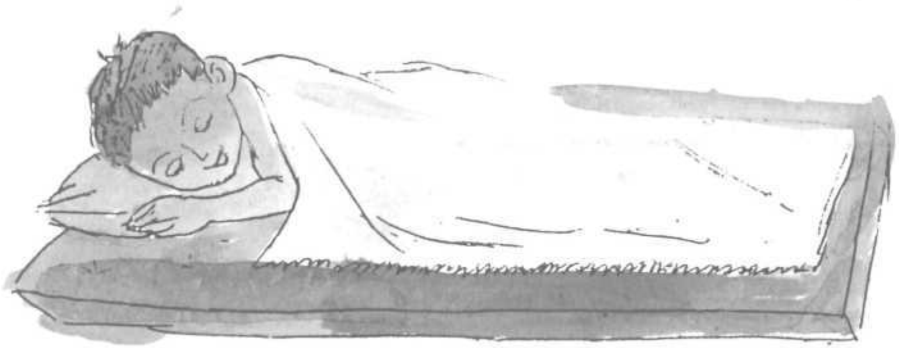

NANTAL
904327

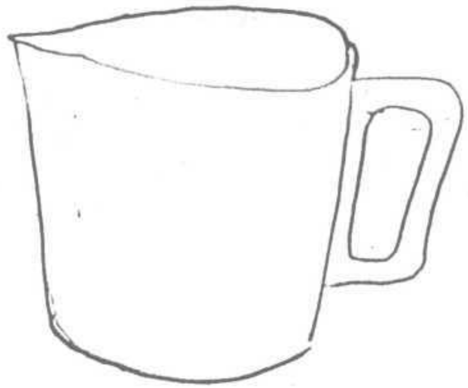




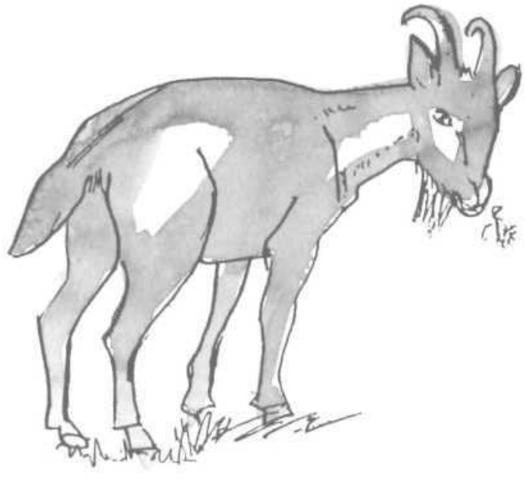


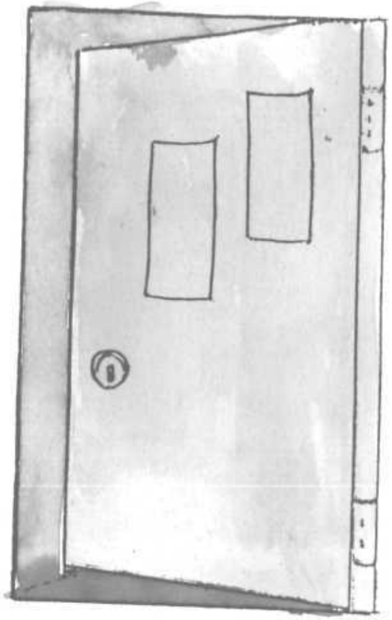


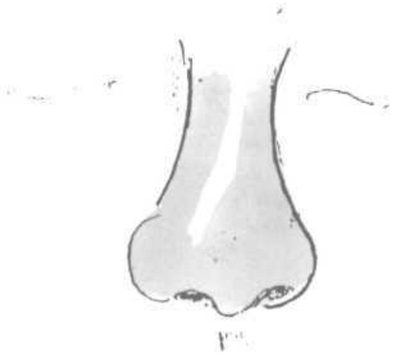




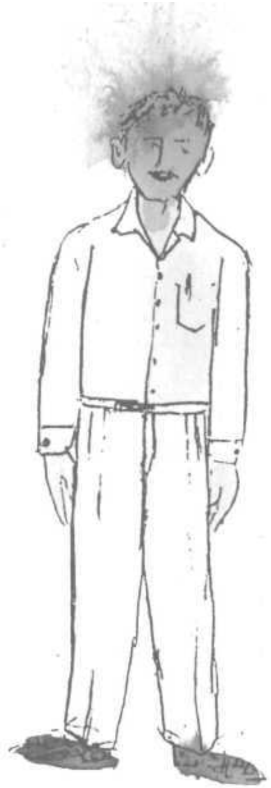
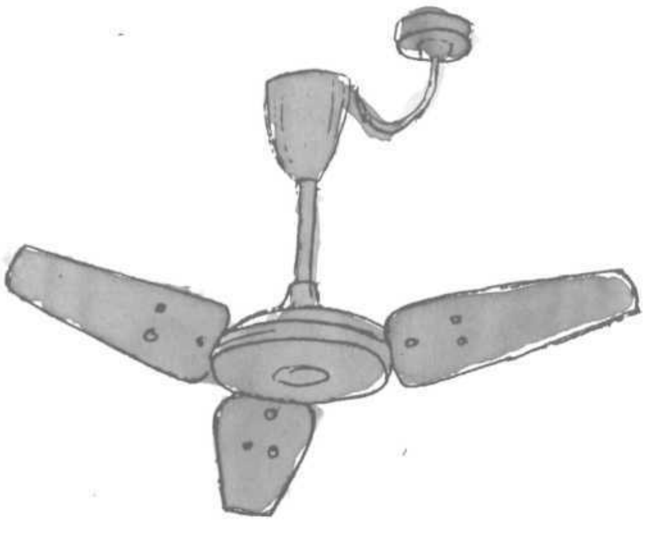

Milk

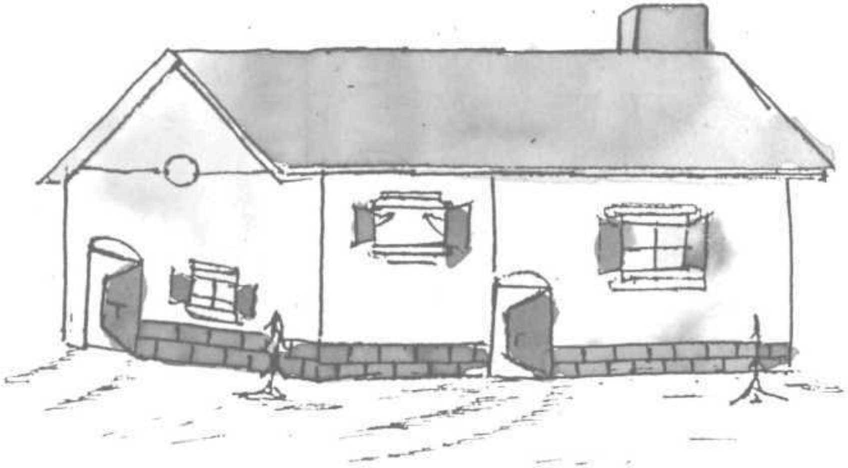




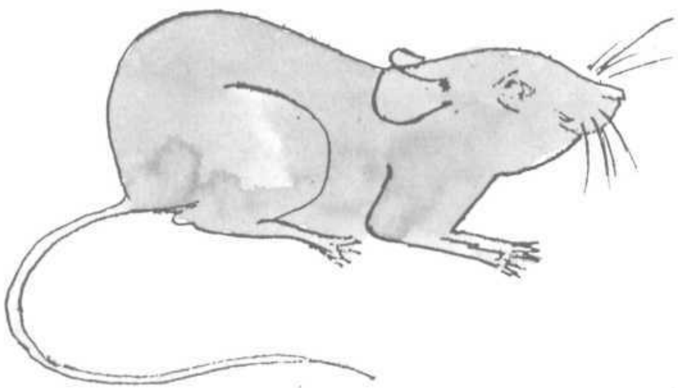



Evita

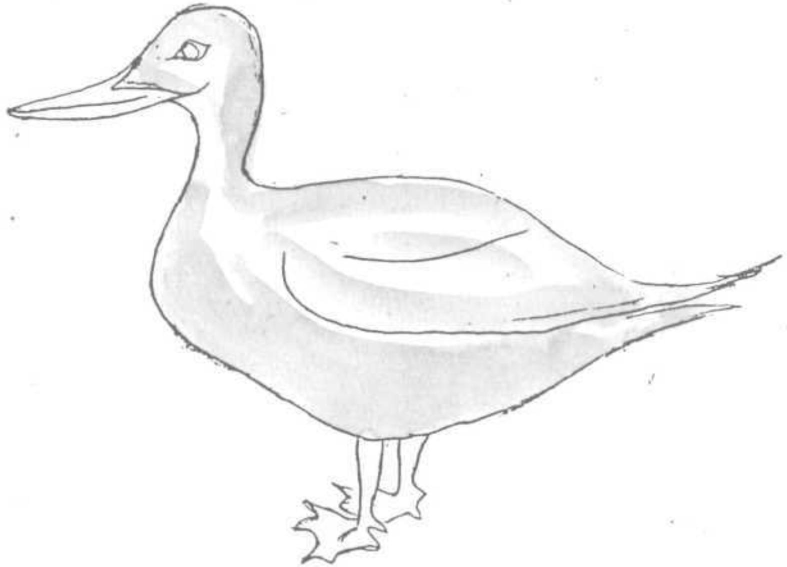




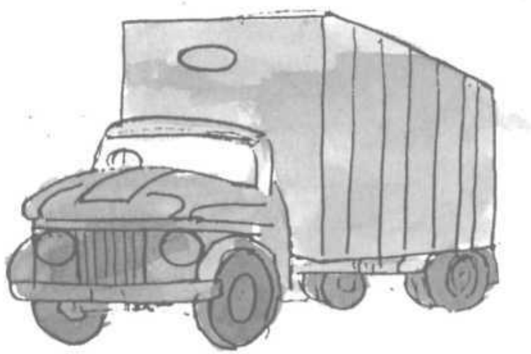




hmt

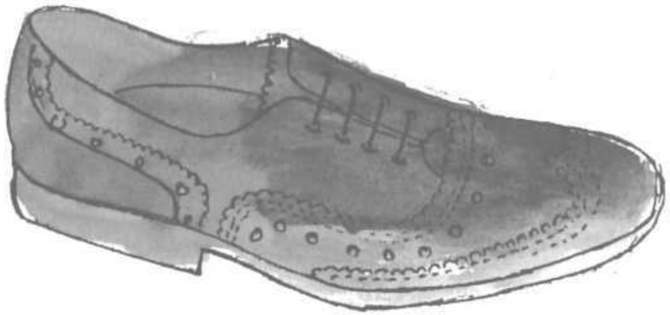


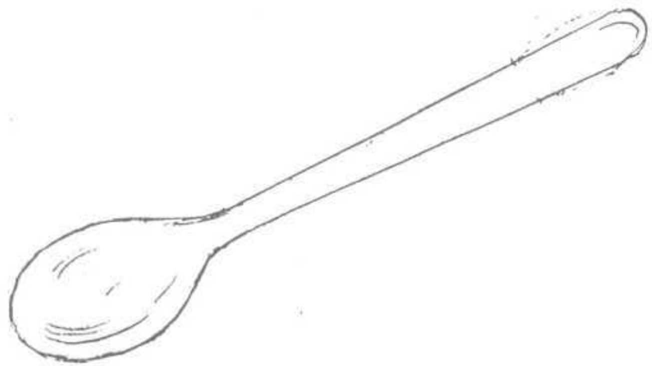

BOY

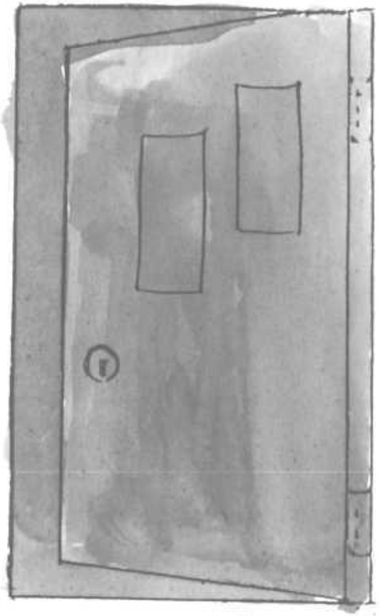


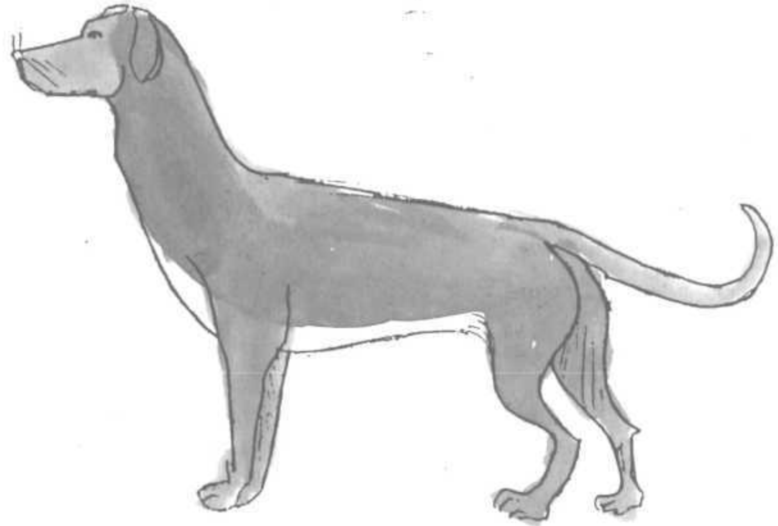


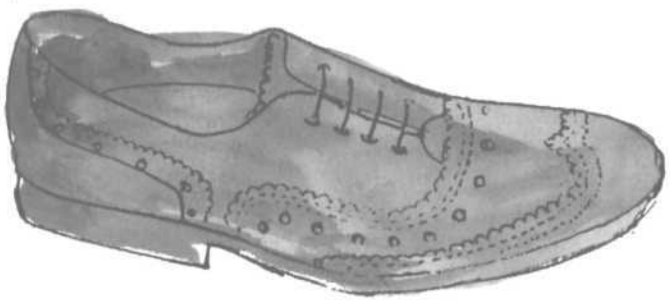

SCHOOL

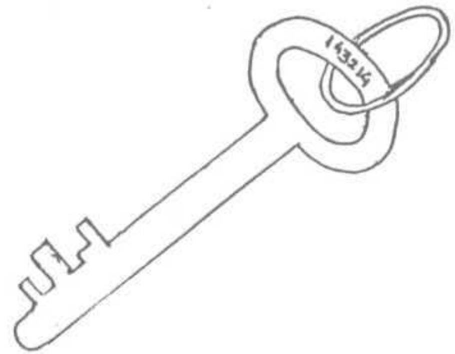


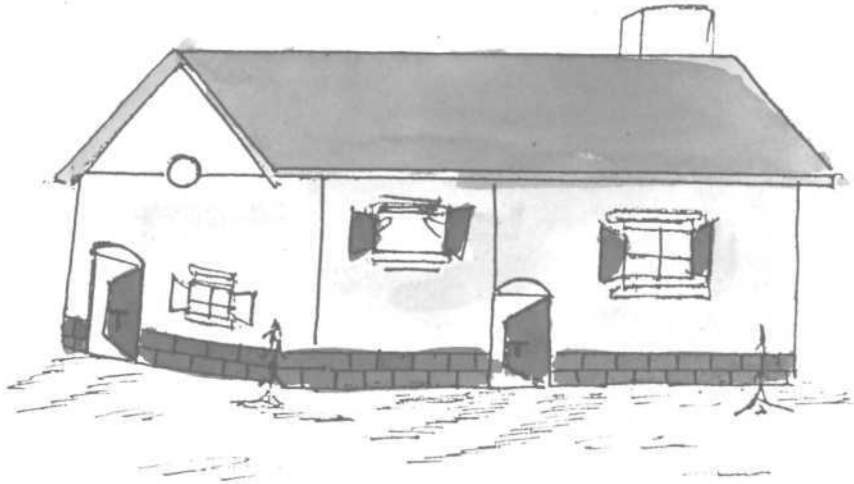


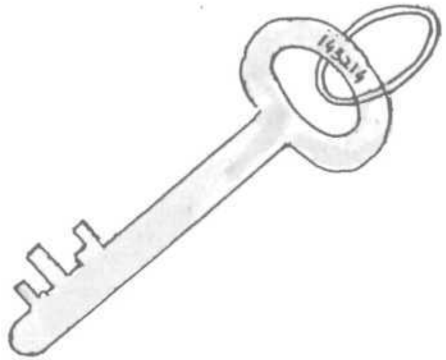


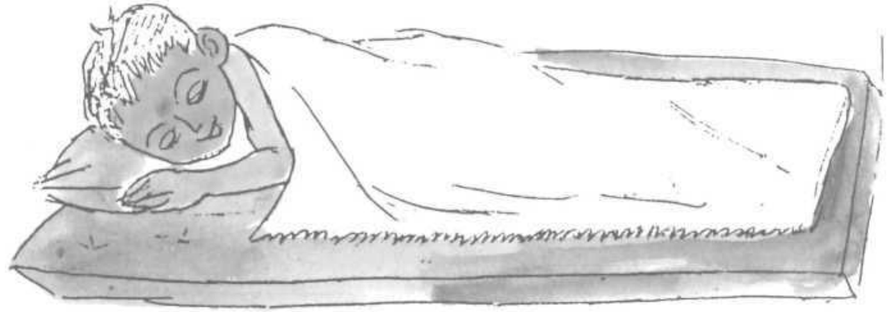


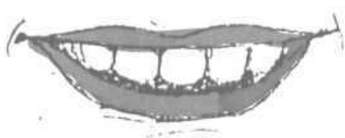




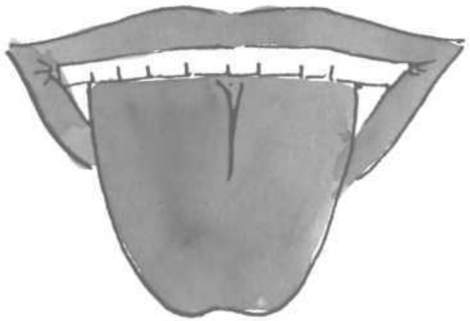


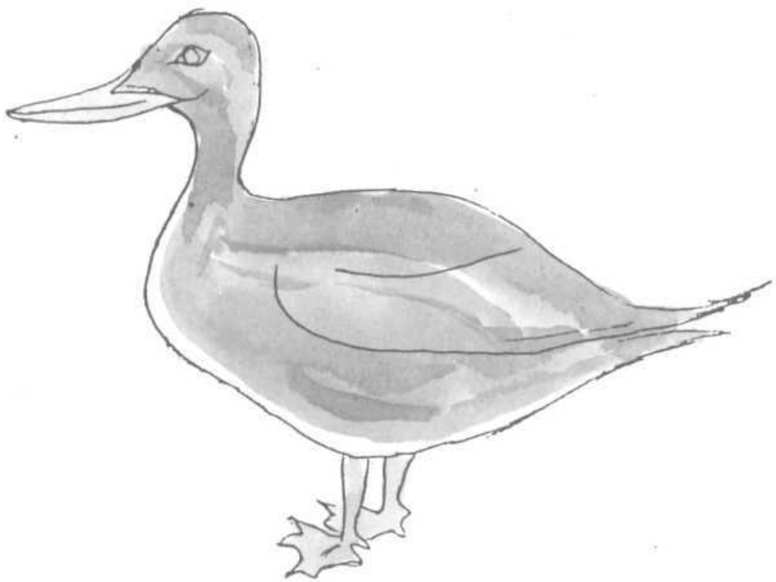


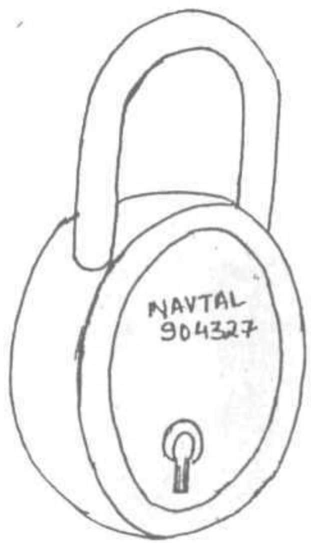


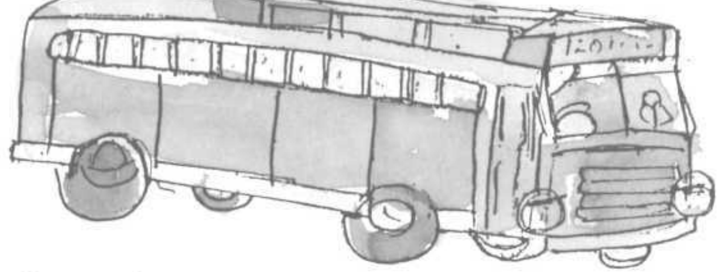


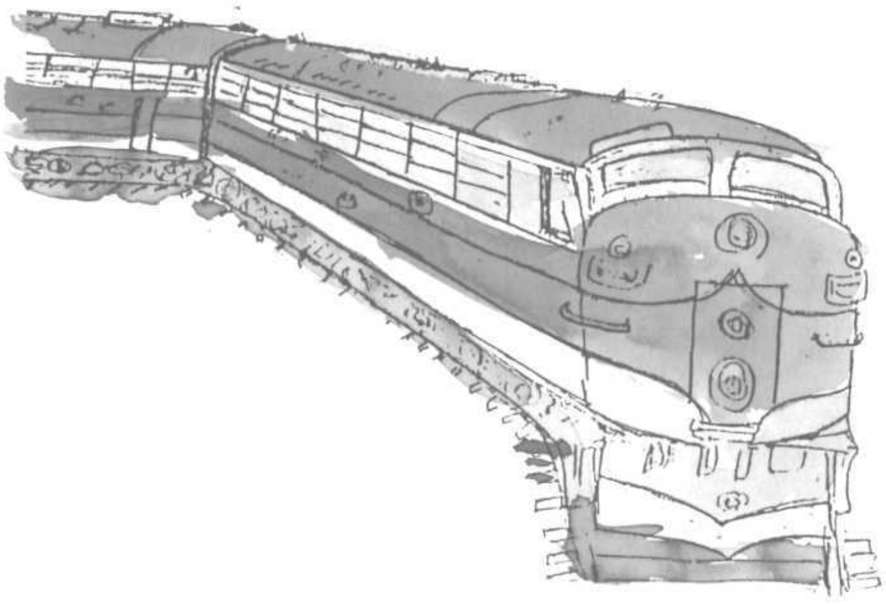

Milk

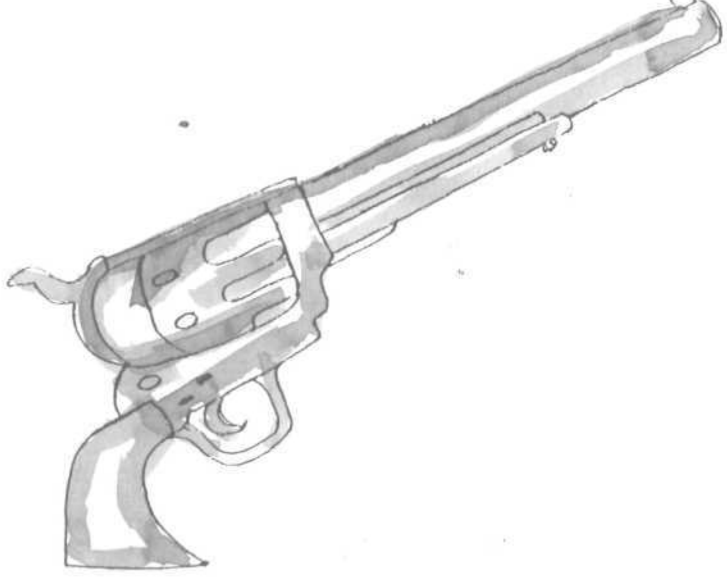




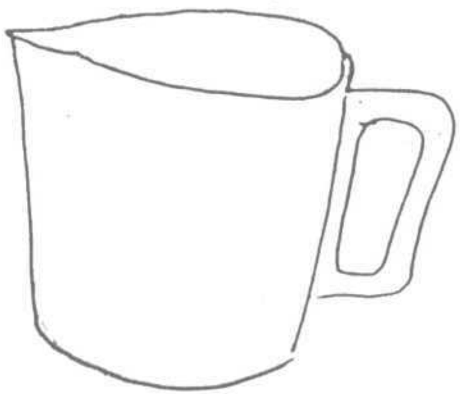

NAVTAL
904327

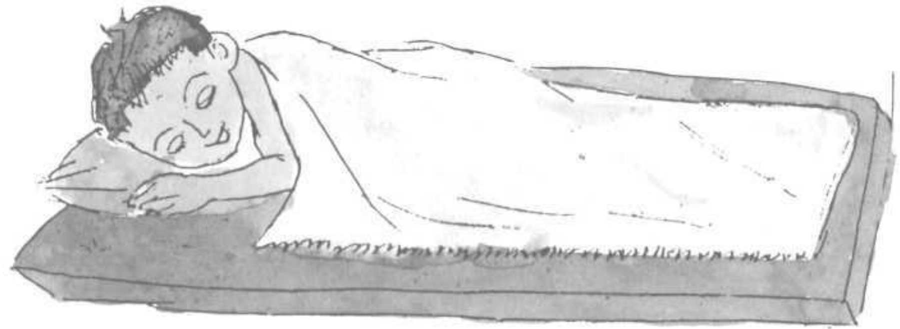


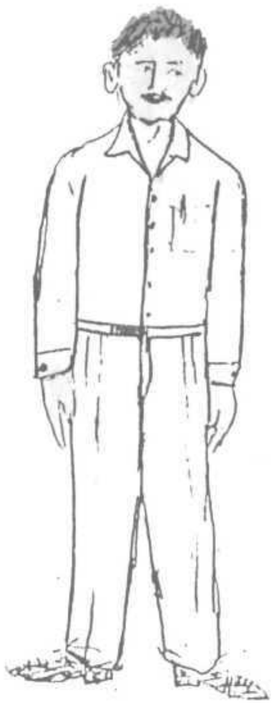


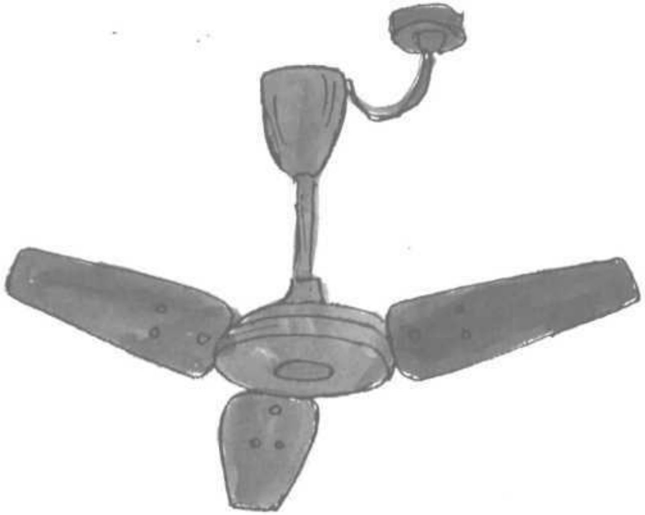


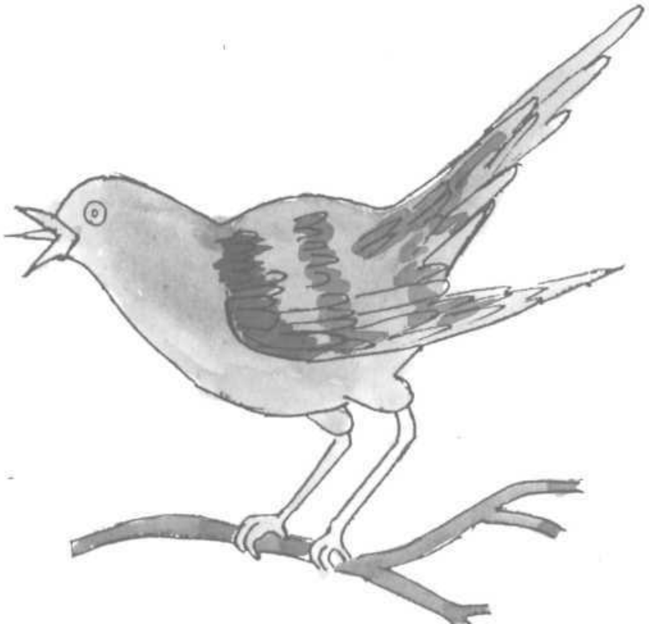

Milk



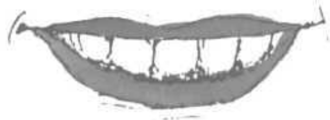


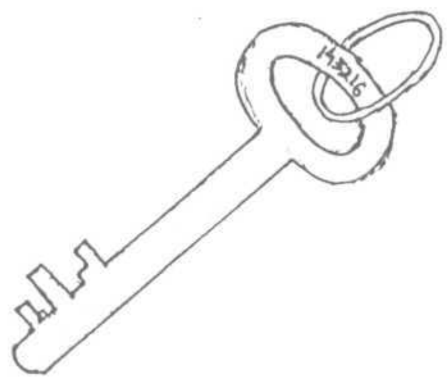


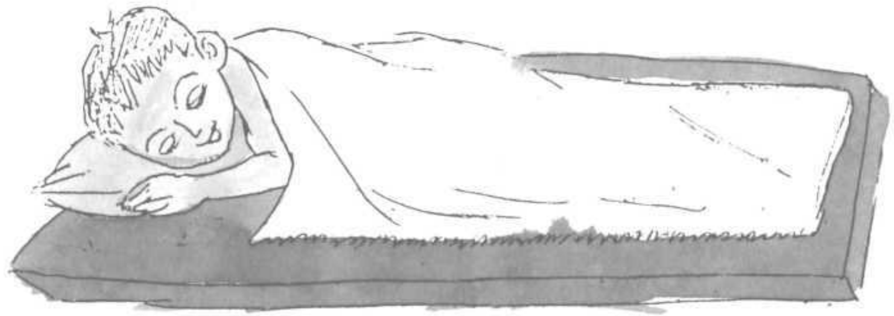


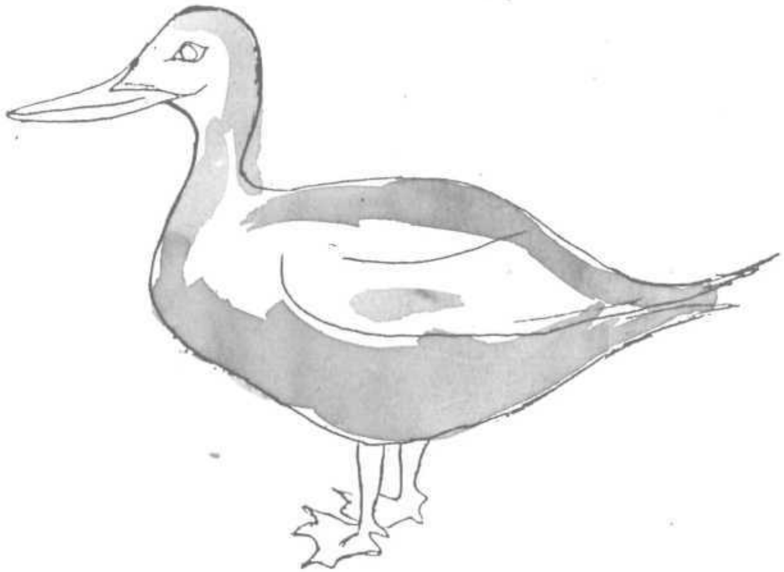


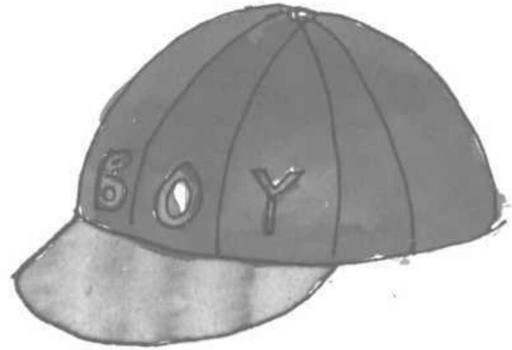
94

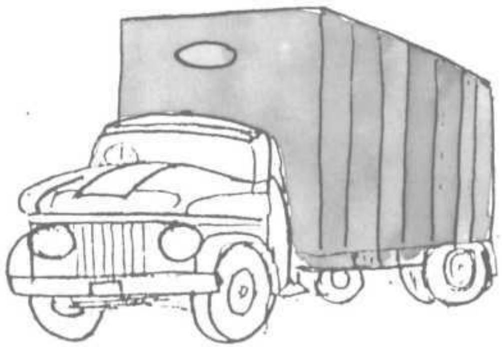


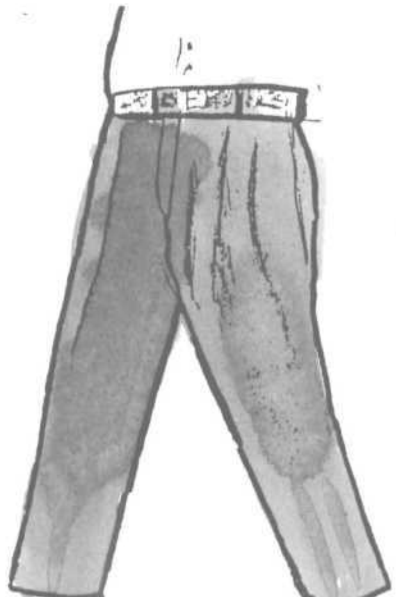


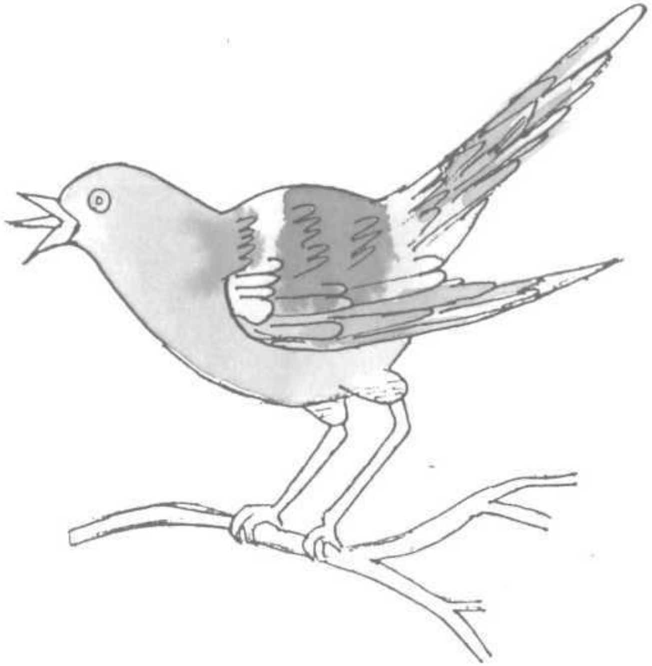


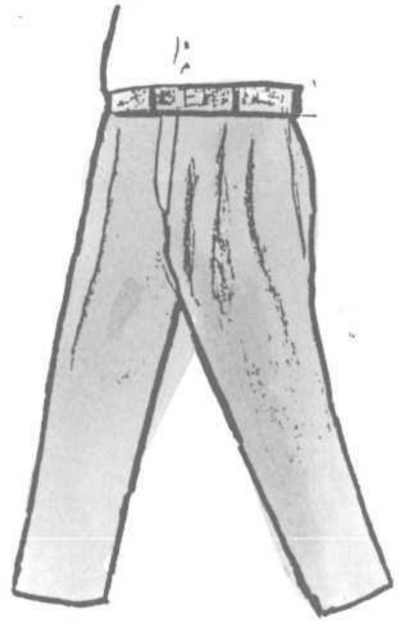


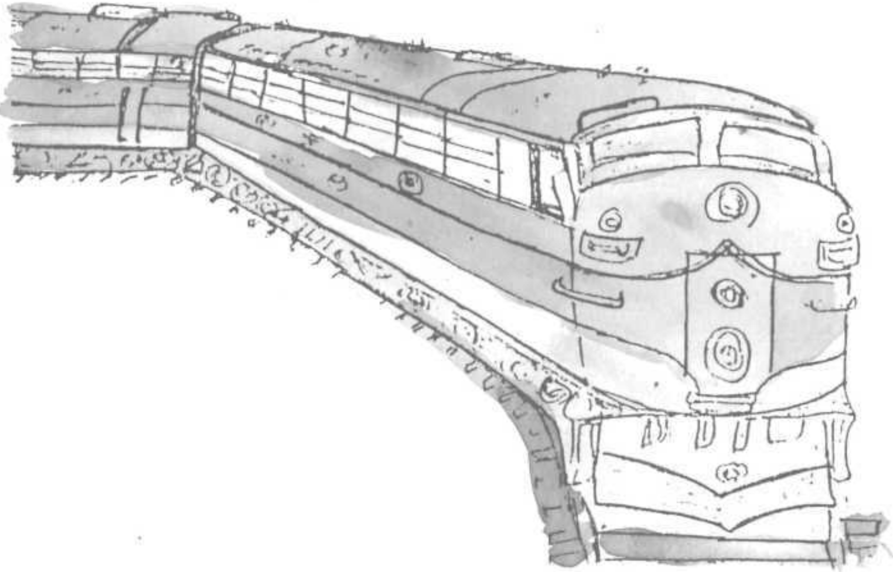


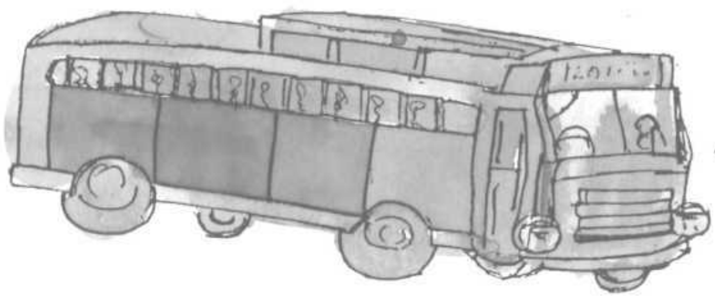


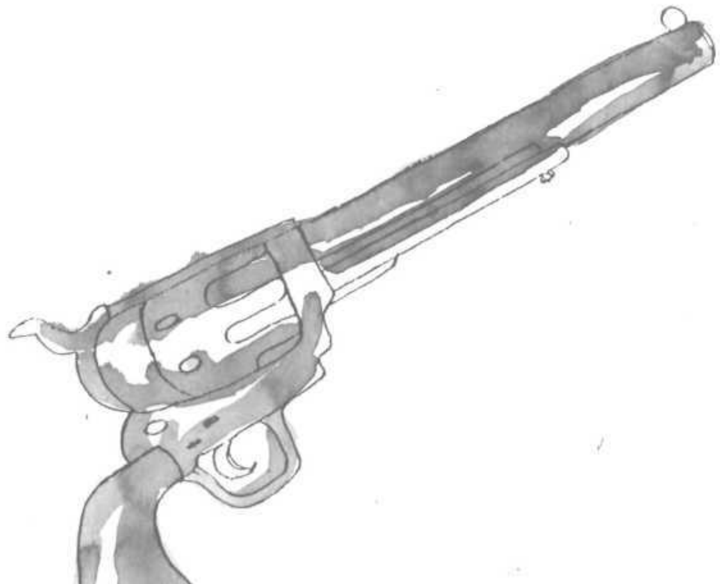


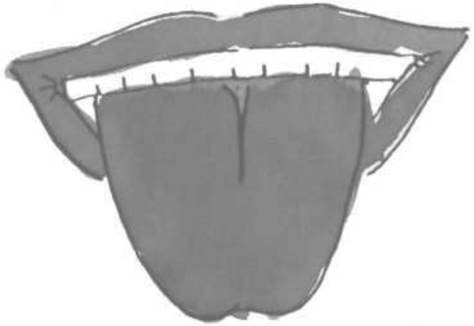


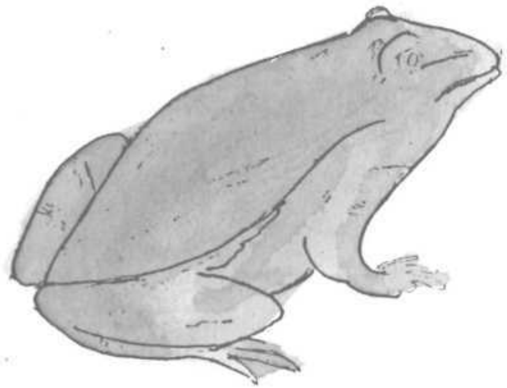


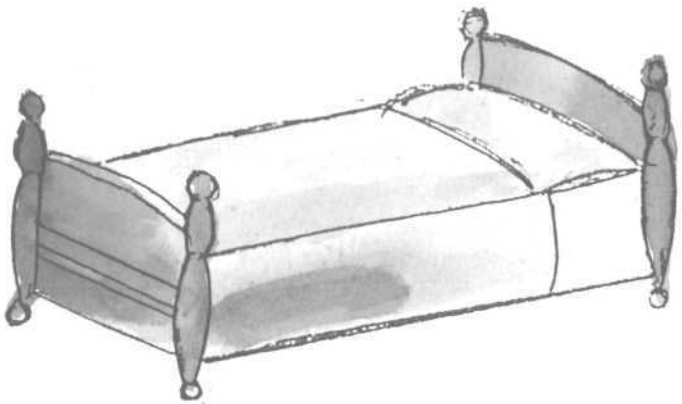


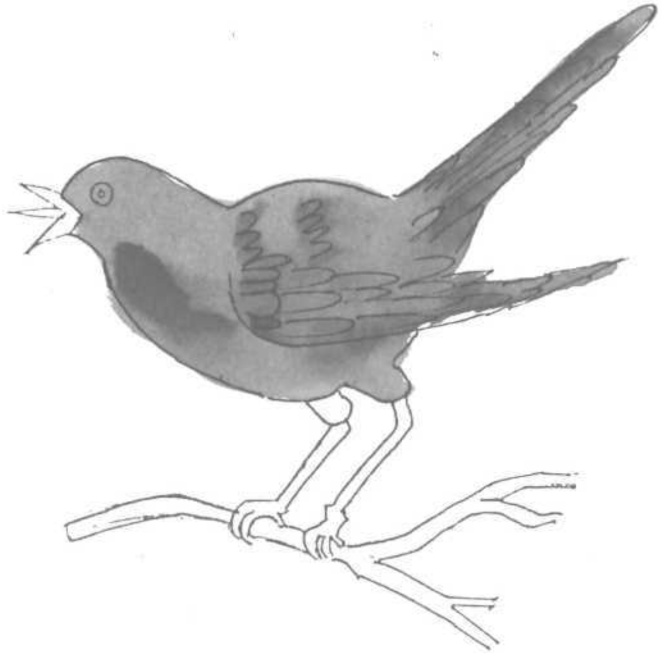


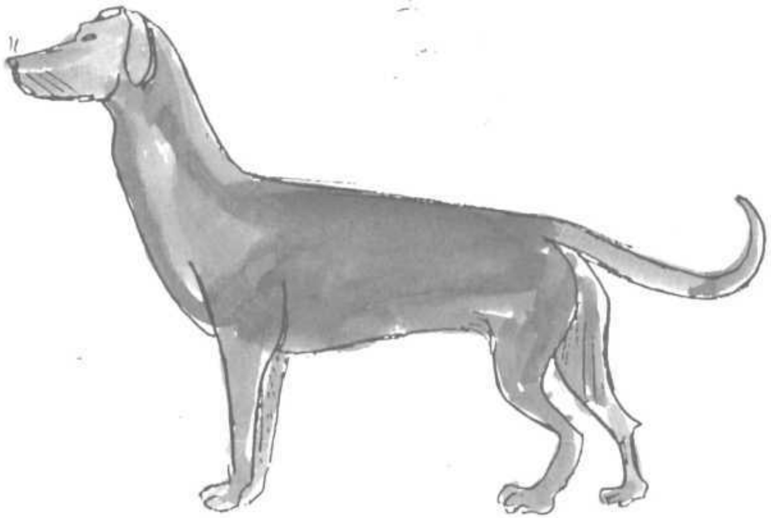


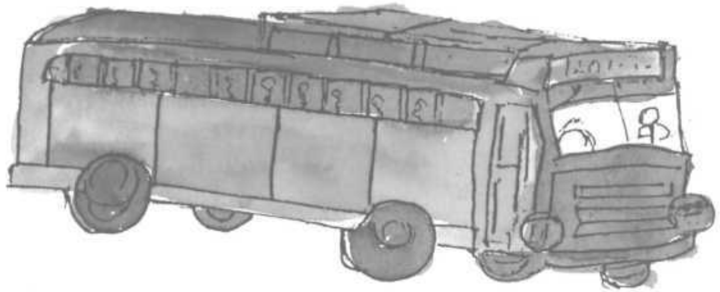




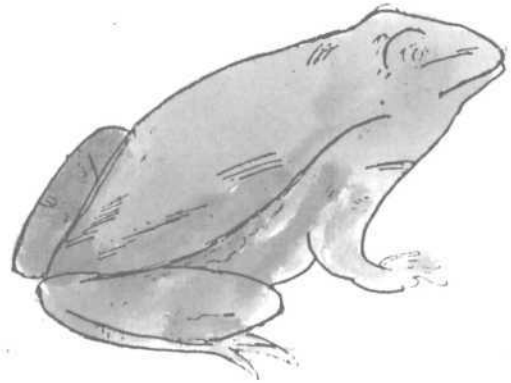


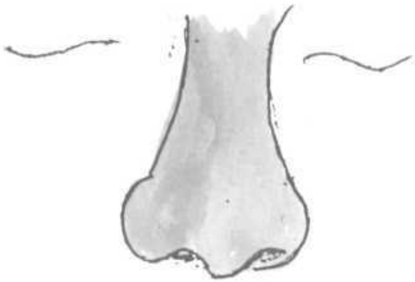


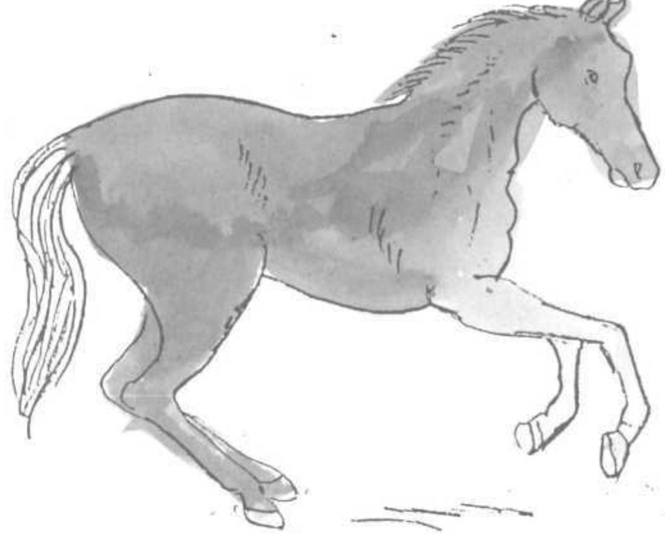


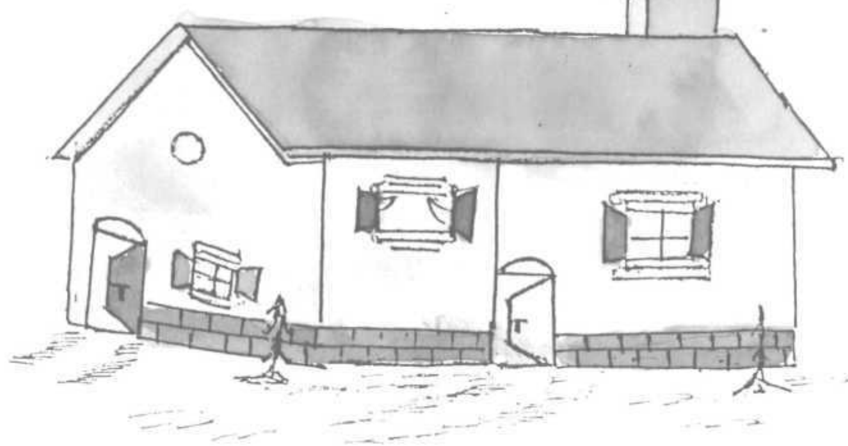


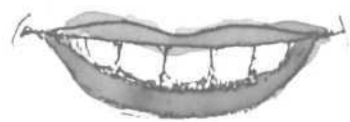

NAVTAL

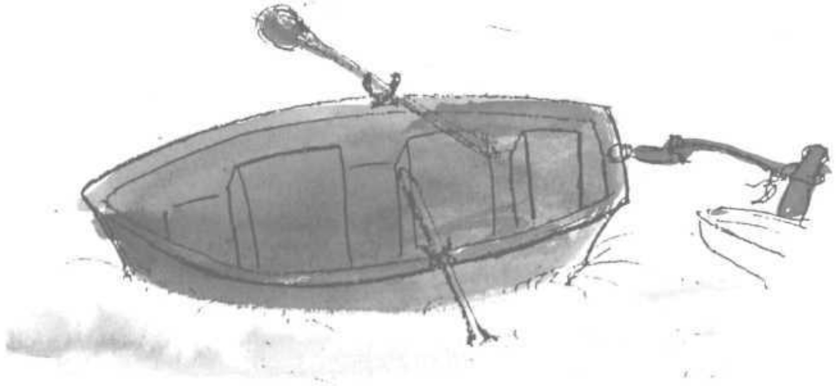


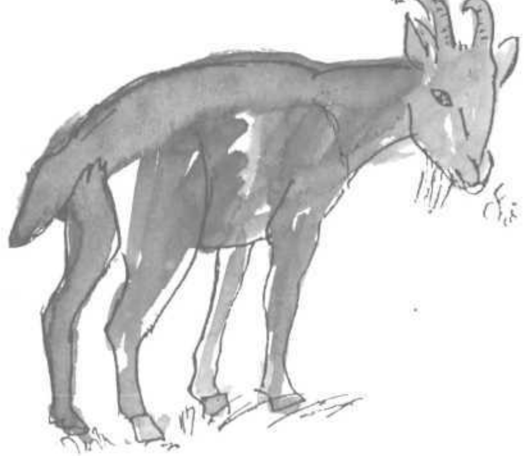








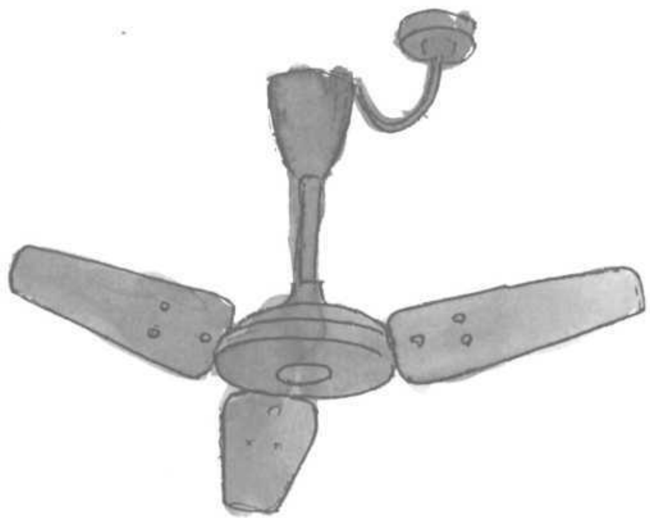


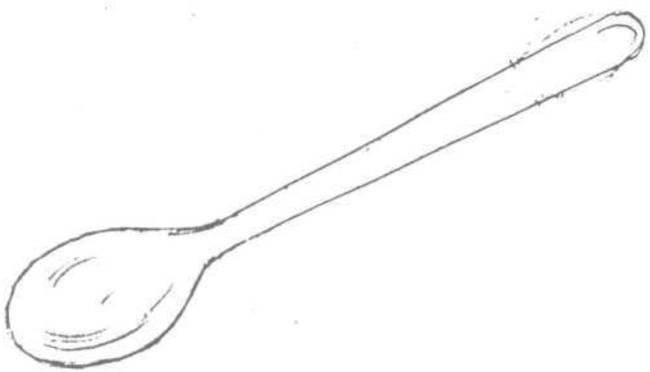


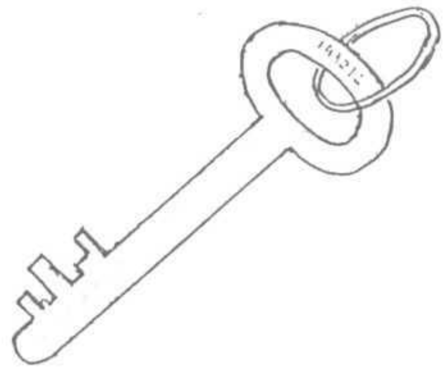

BOY

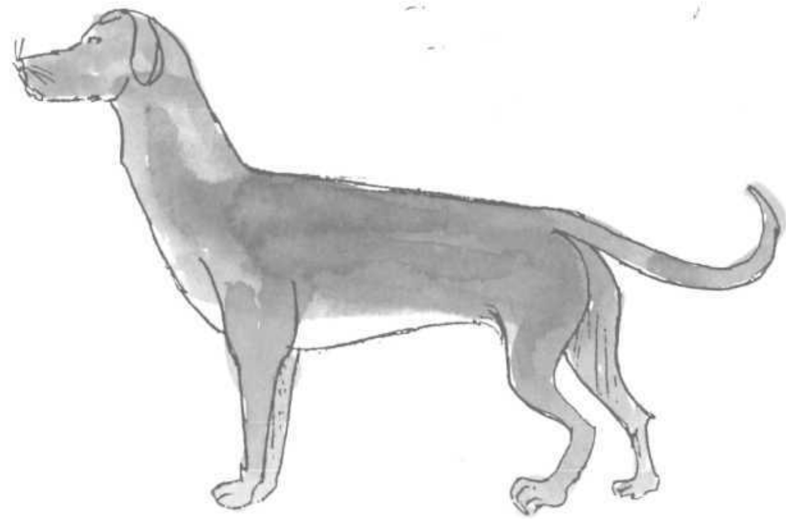

Cvita

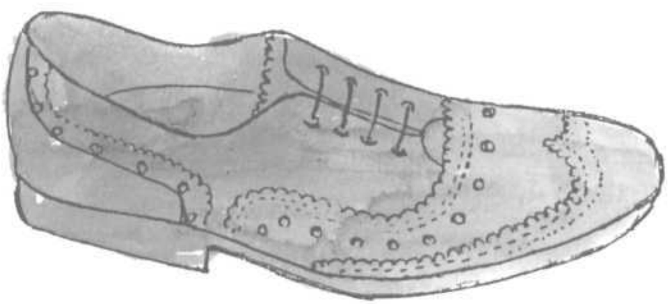


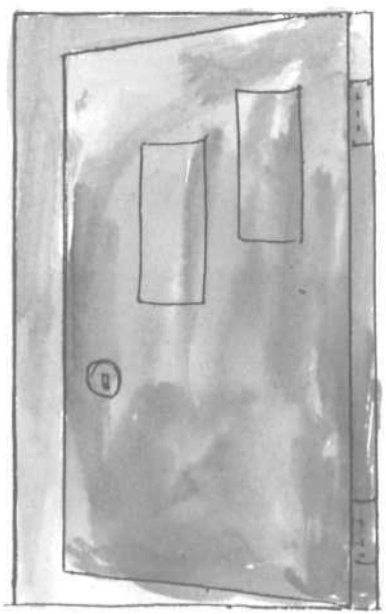



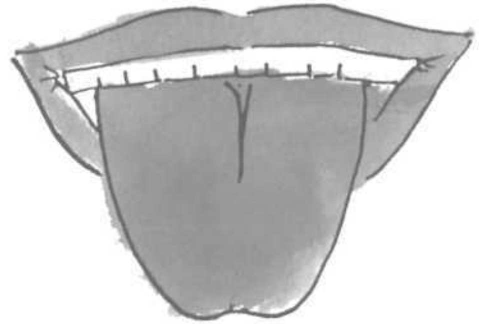


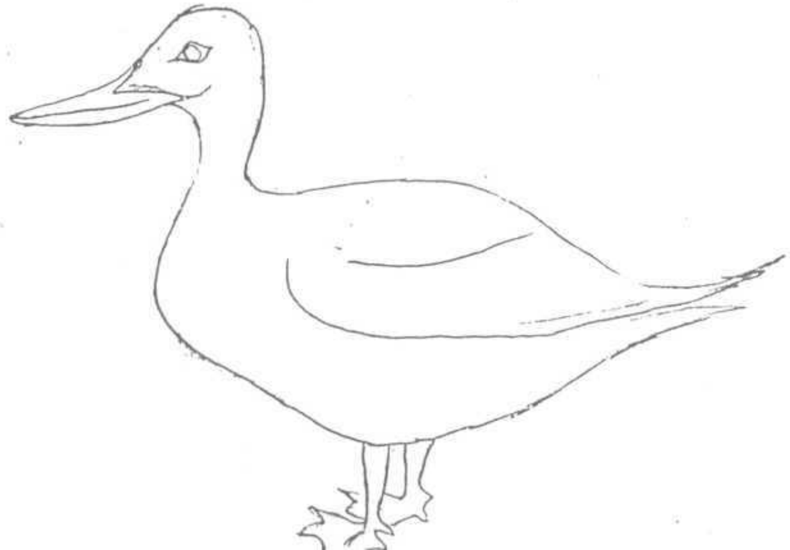


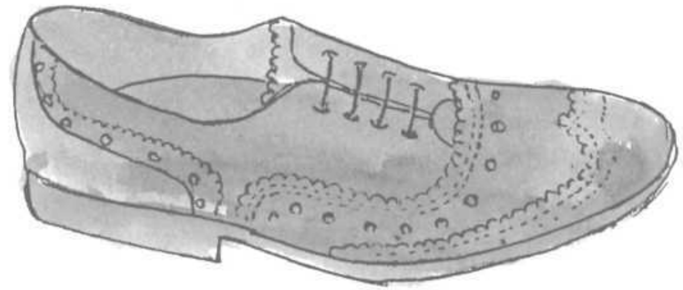




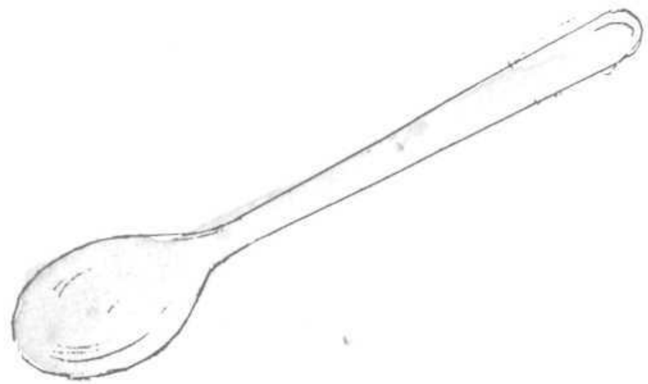


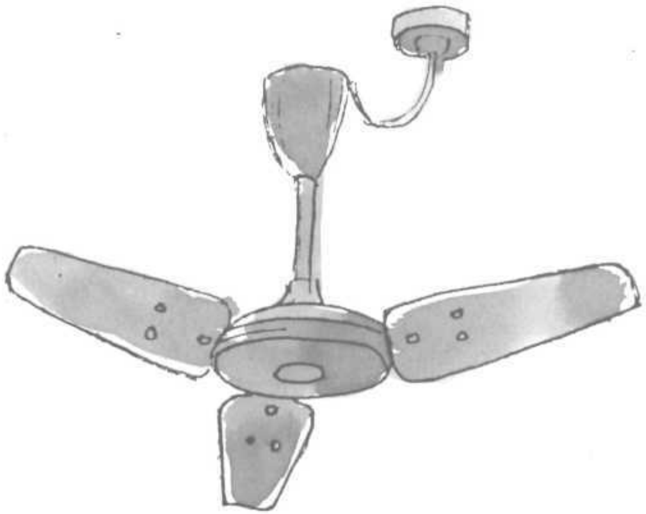


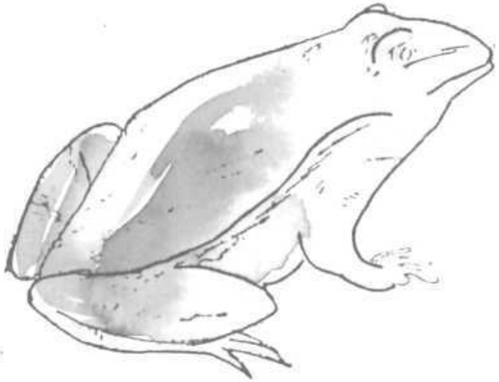


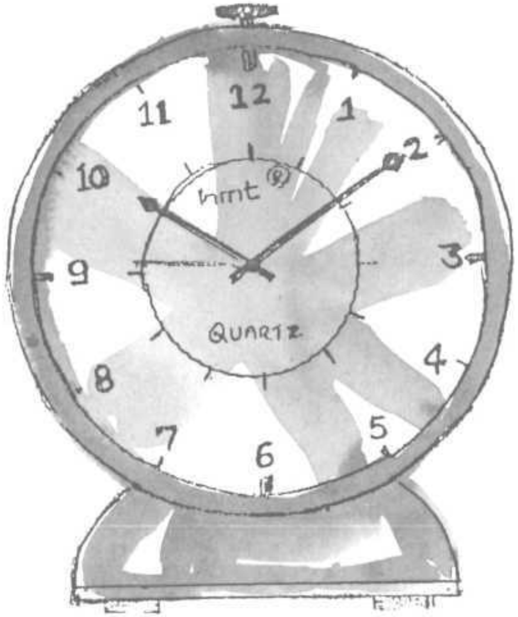


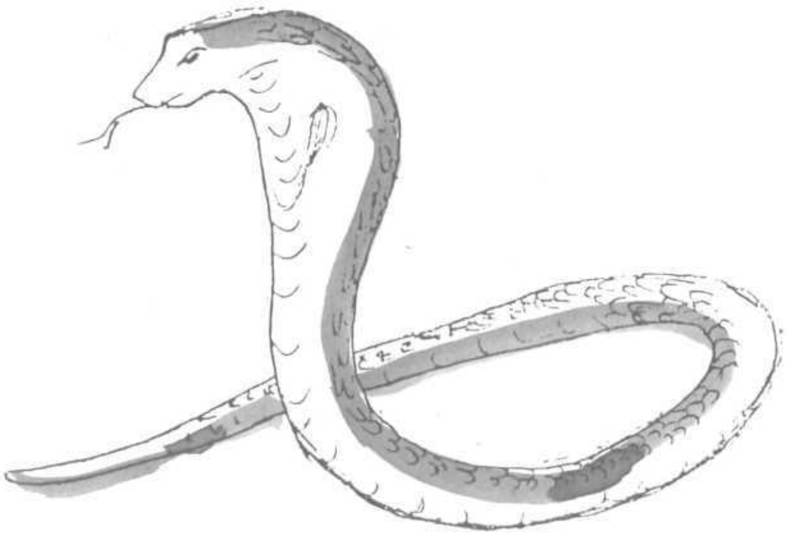

SCHOOL

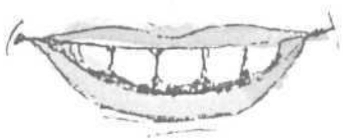


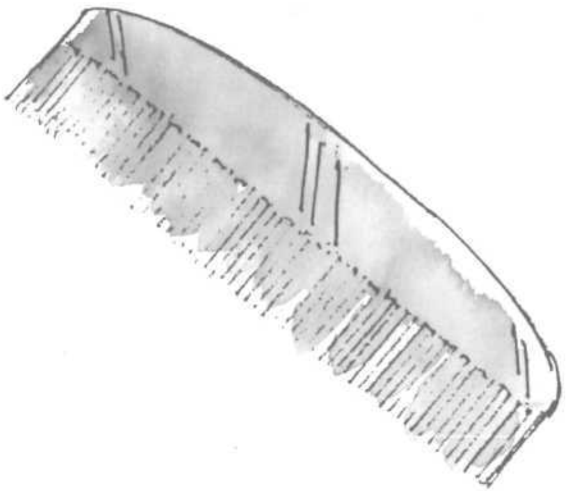


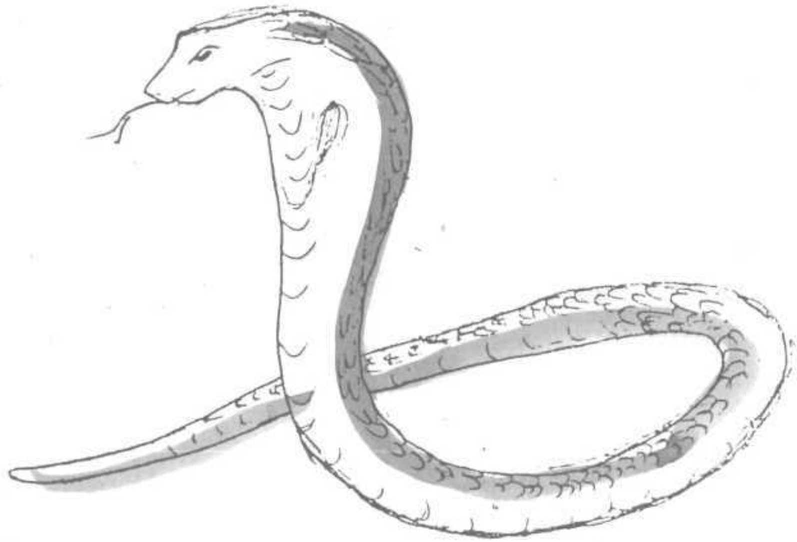


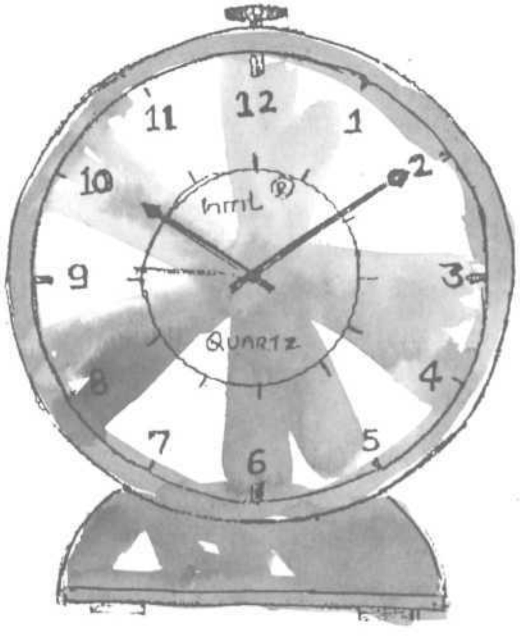

hmt
QUARTZ



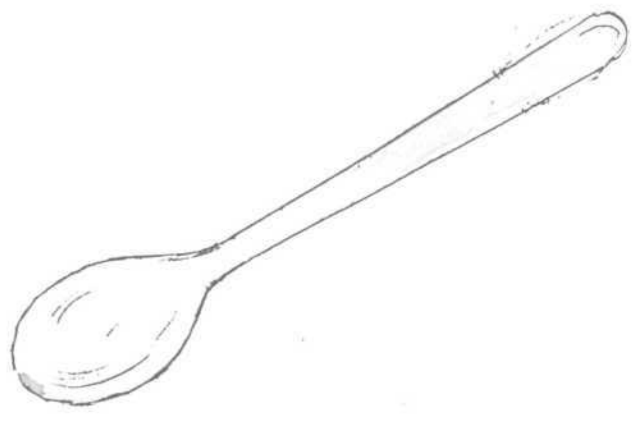




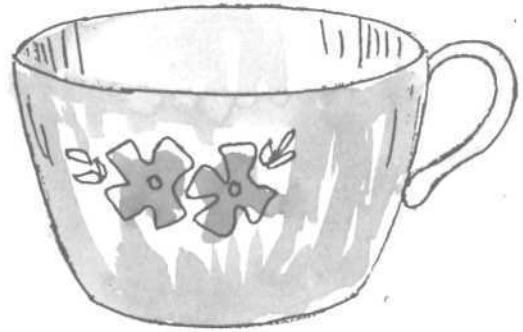


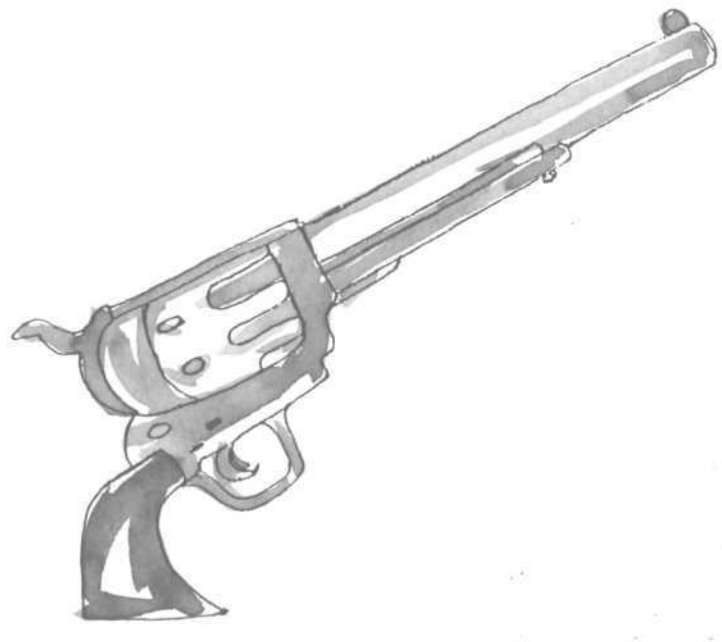

12
1
2
3
4
5
6
7
8
9
10
11
QUARTZ

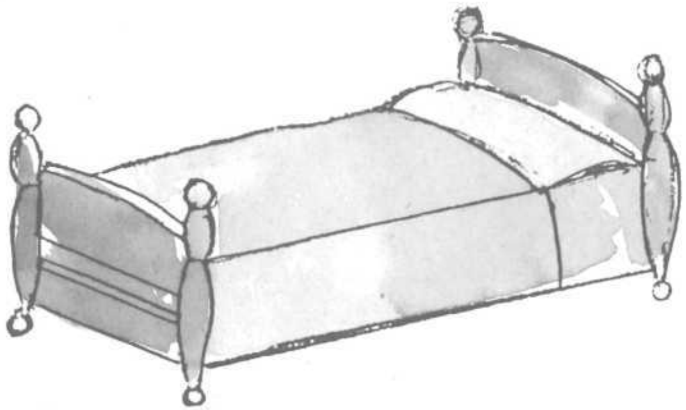
115

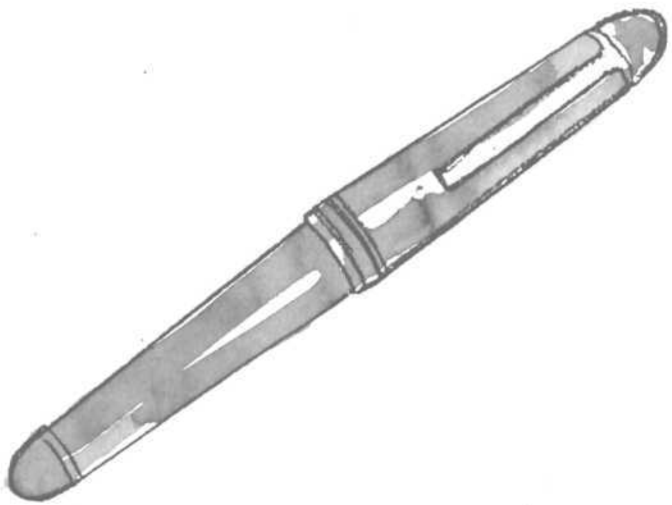


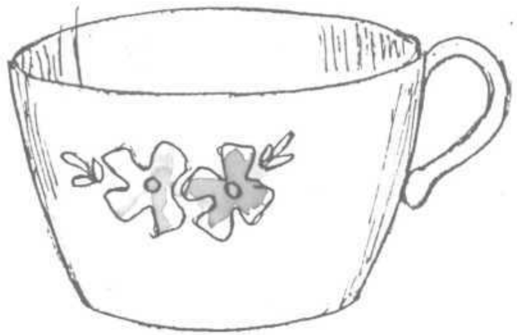
116

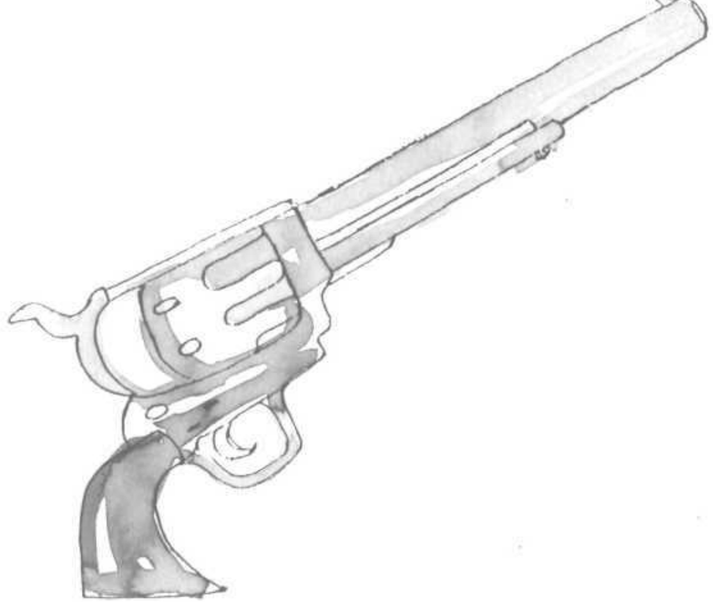


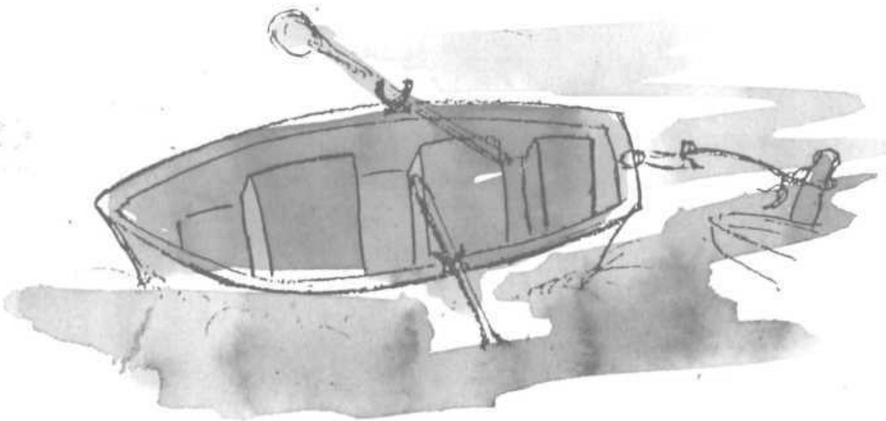


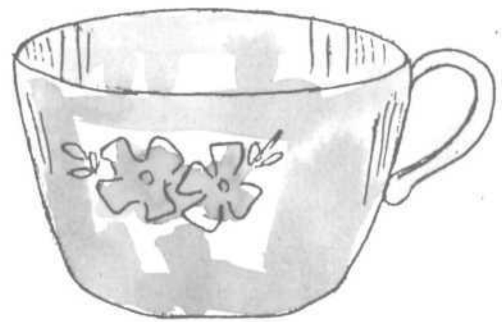


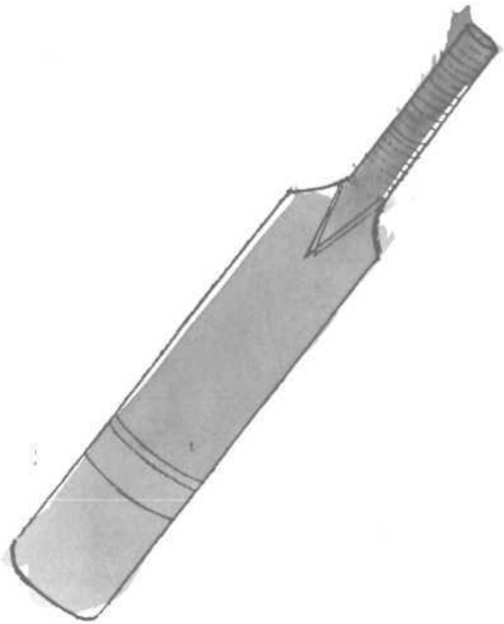


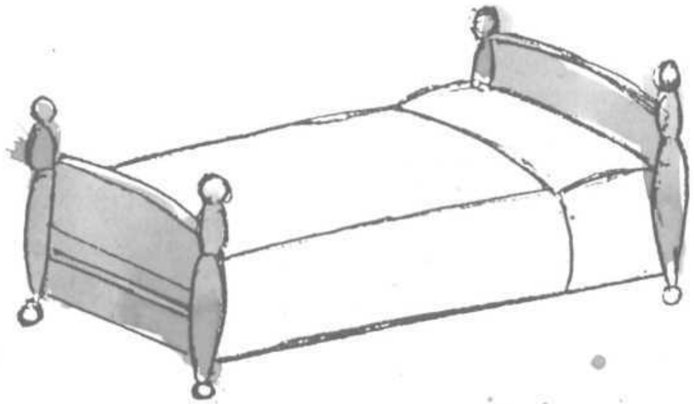



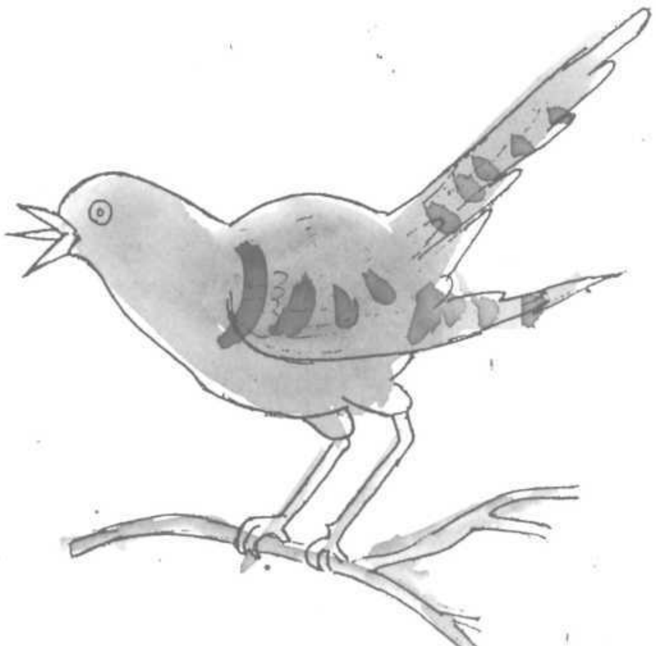


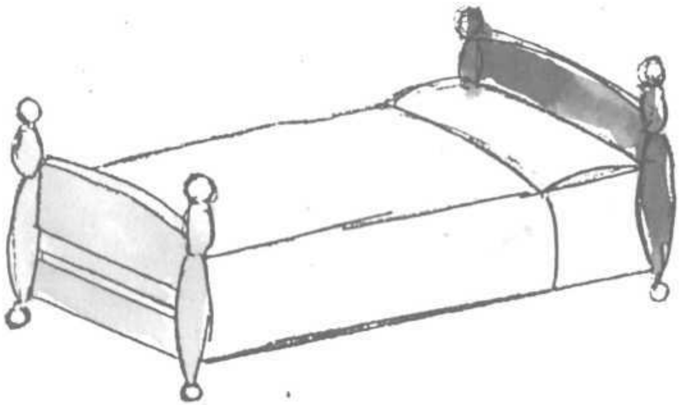
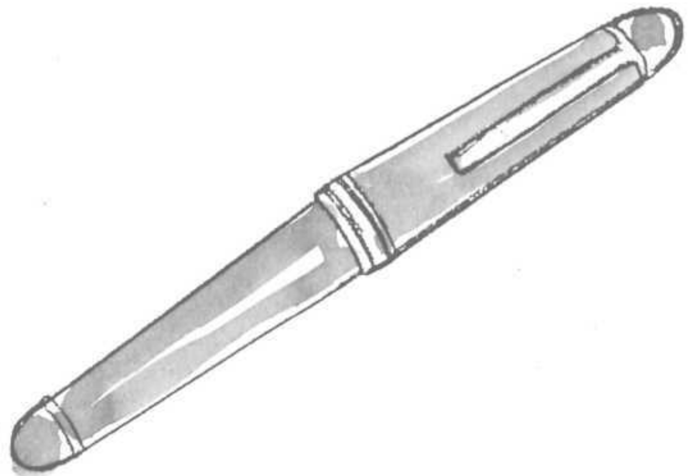


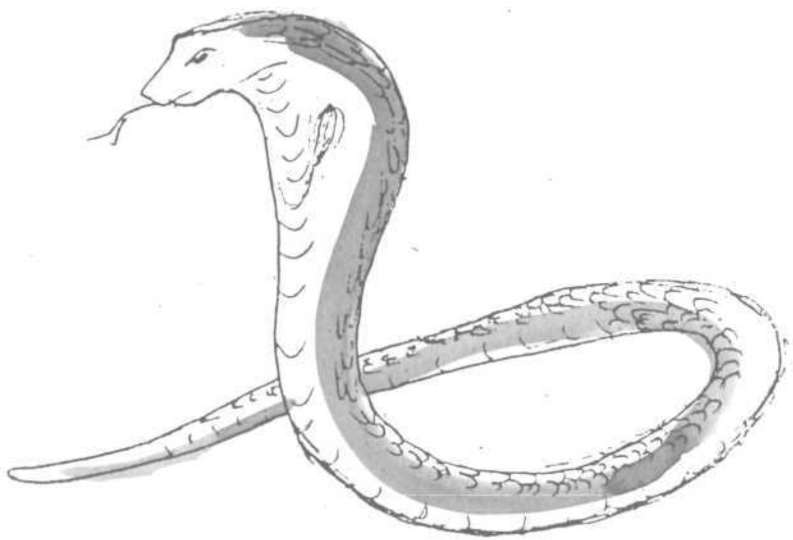


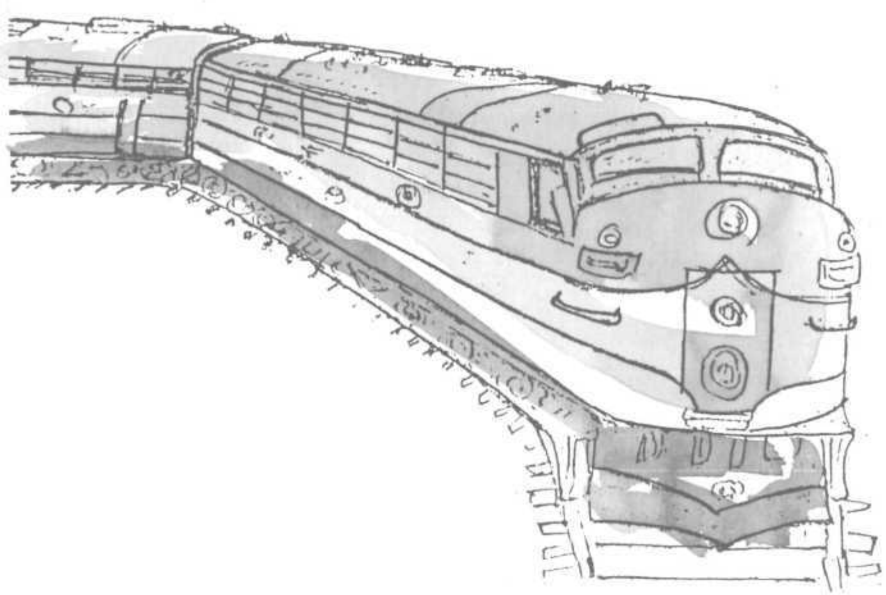


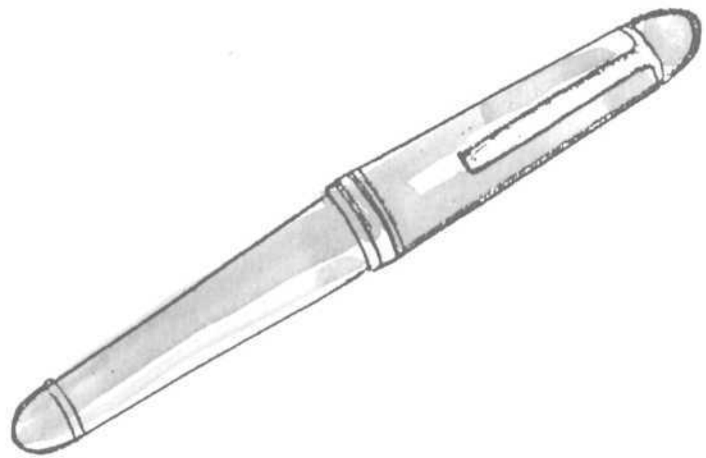


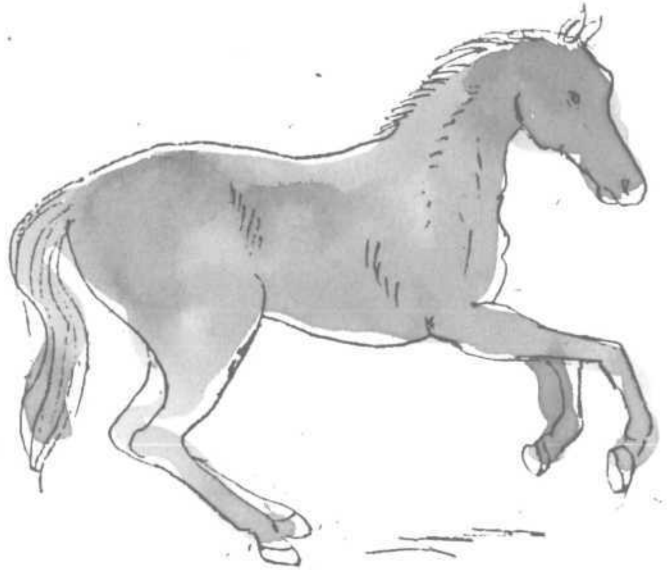


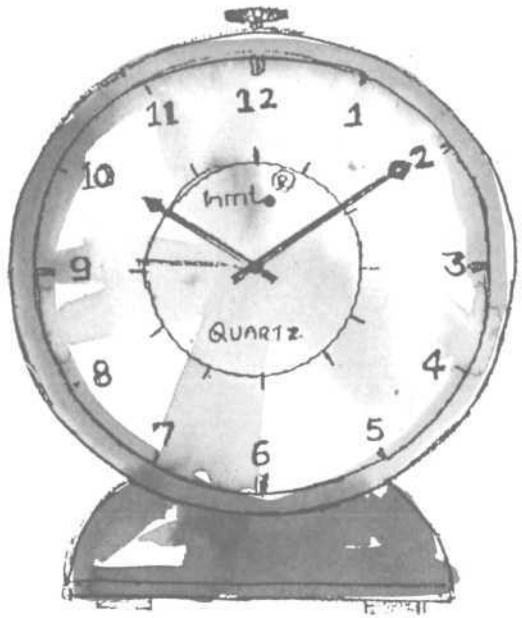



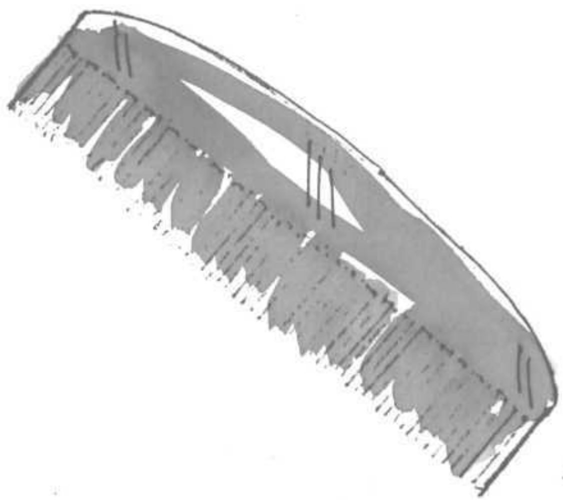





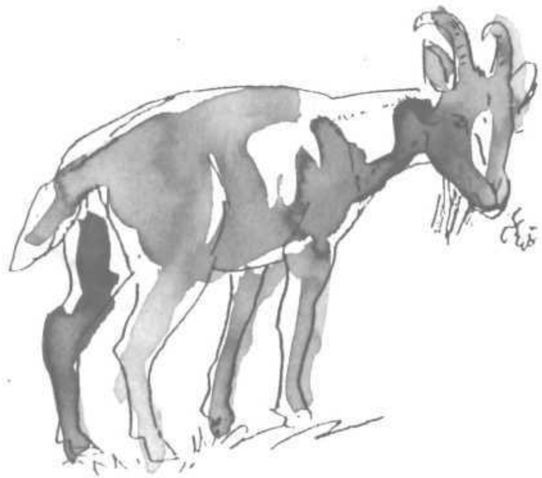


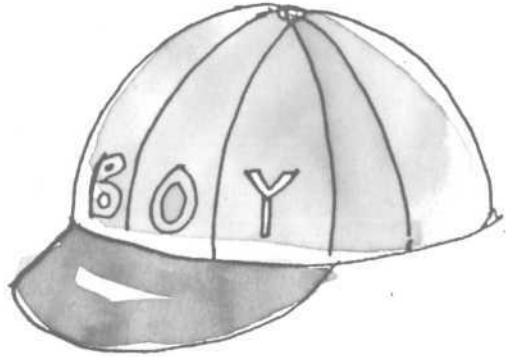



QUARTZ




SCHOOL




BOY


Evita