A PICTURE SOEECH IDENTIFICATION TEST
FOR CHILDREN IN TAMIL

Reg.No.M9812

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

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE 570 006

MAY 1999

Dedication

GURUR BRAHMA
GURUR VISHNU :
GURUR DEVO MAHESHWARAHA
GURU SAKSHATH PARABRAHMA
TASMAI SHREE GURUVEN NAMAHA

Parents were my first teachers, and
Teachers my second parents.
I am indebted to them,
for they have helped me climb
the ladder of knowledge
This work of mine is dedicted to my
TEACHERS
and
To my most loving grand parents.

CERTIFICATE

This is to certify that this Independent Project entitled ***A PICTURE SPEECH IDENTIFICATION TEST FOR CHILDREN IN TAMIL*** *is the bonafide work in part fulfilment for the degree of Master of science (Speech and Hearing) of the student with Register* ***No.M9812.***

Mysore
May, 1999

Dr. (Miss) S. Nikam
Director
All India Institute of
Speech and Hearing
Mysore 570 006.

C E R T I F I C A T E

This is to certify that this **Independent Project entitled : *A PICTURE SPEECH IDENTIFICATION TEST*** *FOR CHILDREN IN TAMIL* has been prepared under my supervision and guidance.

Mysore
May, 1999

Asha Yathiraj.
Dr. Asha Yathiraj

Reader inAudiology
All India Institute of
Speech and Hearing
Mysore 570 006.

DECLARATION

This Independent Project entitled ***:A PICTURE SPEECH IDENTIFICATION TEST FOR CHILDREN IN TAMIL*** is the result of my own study under the guidance of Dr.Asha Yathiraj, Reader in Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other diploma or degree.

Mysore
May, 1999

Reg. No.M9812

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"Children are the most wholesome part of our race, the sweetest for they are freshest from the hands of God. Whimsical, ingenious, mischevious, they fill the earth with joy and good humour .... " Thank you buddies, I shall never be able to forget my experience with you.

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Above all I thank, the ALMIGHTY for giving me courage and strengh to complete this proejct.

These are a few strings of words which proclaims my immense regard for many but...

"Do hands talk on mind's behalf?" .....

Investigator.

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INTRODUCTION

Speech may be defined as a form of oral communication in which transformation of information takes place by means of speech waves which are in the form of acoustic energy (Fant, 1960). Speech is a fascinating human attribute that can be analysed, synthesized and recognized. The human ear which is highly sensitive and versatile seems to be custom built for the purpose of detecting and analyzing sounds.

The speech signals which are long spurts of a complex and constantly changing stream of sounds radiate from the speaker's lip, travel in air, impinge upon the eardrum of thelistener and reach the higher cortical structures through middle and inner ears and the auditory pathways. Almost from birth, an infant begins the process of learning language which forms the basis for the other aspects of development. An infant with adequate hearing will learn langauge skills primarily through the auditory channel. Communication of thoughts and ideas are essential for natural learning of language. Even though communication can occur through pointing, writing and gestures, speech is the most often used way to communicate with the immediate environment. The ability to communicate meaningfully and to understand speech has been considered as an important factor in differentiating humans from other forms of life (Sanders, 1982).

The onset of auditory impairment in an individual impedes the ability to communicate meaningfully and to understand speech. Therefore, it is the foremost duty of an audiologist to identify, evaluate and rehabilitate these aurally handicapped individuals. There are several tests which come handy to the audiologist to make an accurate and effective diagnosis. Speech audiometry form an integral part of these groups of tests.

Speech Audiometry - Its Relevance in Diagnostic and Rehabilitative Audiology

One of the earliest documented literature of the use of speech stimuli to evaluate the hearing ability of individuals is by Wolf (1874). According to him "Human voice is the most perfect conceivable measure of hearing". Until the turn of this century, speech was considered as a major assessment tool. Later puretones, noises, warble tones and many other stimuli were used to evaluate hearing sensitivity. Bunch (1934) reported that puretones produce low percentage of responses and are not as effective as speech. Assessment of hearing using puretones provide information regarding the sensitivity but not on the receptive auditory ability (Elliot, 1963; Harris, 1965 and Marshall and Bacon, 1981).

Speech materials have become indespensible tool in clinical evaluation for various reasons. These include the following :

1. They have been used to confirm puretone thresholds.
2. A discrepancy in the threshold of hearing and the threshold of intelligibility indicates functional hearing loss (Ventry, 1976).
3. Threshold of discomfort and comfort can be determined using speech tests.
4. Speech can be used to test difficult to test population.

5. Speech discrimination abilities are found to be disturbed ink central auditory processing disorders, which are not manifested in peripheral hearing loss, but can be found using a speech test (Jerger and Jerger, 1974 and Jerger and Hayes, 1971). Higher auditory function can be tested using filtered speech and time compressed speech test (Bocca and Calero, 1963; Luterman, Welsh and Melrose, 1966; Beasly, Schwimmer and Rinteknann, 1972).
6. Speech materials are also used in hearing aid selection, prescription and rehabilitation (Markides, 1977).
7. Speech can be used to evaluate the efficiency of various rehabilitative procedures such as effects of auditory training.
8. Speech tests determine the form of rehabilitation, i.e. whether the person should use a hearing aid or undergo cochlear implant surgery.
9. They can also be used to determine training strategy to be used with cochlear implantees.

Thus, speech stimuli act as a versatile stimuli and speech audiometry can be considered to have a major role in both diagnostic and rehabilitative audiology.

Need for Speech Identification Test in Tamil

India is a multilingual country with 15 official languages and 1652 dialects spoken across different cultures and geographical boundaries (Manorama Year Book, 1996). Attempts todate on the development of speech tests for the Indian population includes speech tests in Hindi (Abrol, 1971); Malayalam (Mathew, 1996), Tamil (Kapur, 1971 and Samuel, 1976), Bengali (Ghosh, 1988), English **for** Indian children (Rout, 1996), Kannada (Hemalatha, 1981 & Vandana, 1998). Most of these tests catered to adult population with exception of Vandana's (1998) Rout's (1996) and Mathew's (1996) **and** Hemalatha's (1981).

In the present trend of mechanistic, modern swift life, the then Darwin's theory, survival of the fittest needs an amendment as "Survival of the fastest", implying, early identification is the need of **the** hour. So it necessiates more and more tests to identify hearing-impairment early in children.

Thus the present study aims to cater to the needs of Tamil speaking children (Tamil is a language spoken by the native people **of** the state of Tamilnadu, in south India. It is also classified as a Dravidian Language, Ramakrishna et al. 1962).

Objectives of this Study

The aim of this study is to develop a speech identification test for Tamil speaking children in the age range of 3-6 years. The test is phonemically balanced bisyllabic, closed set picture test using a picture pointing task.

The study also aims in

a) Evaluating the effect of presentation level on speech identification scores.

b) Studying the effect of age of speech identification scores.

c) Comparing the performance with the half and full lists.

d) Comparing the reliability between the half lists.

Implications of the study :

The present study helps in evaluating speech identification abilities in children with hearing disorders.

Knowledge about the relationship between the presentation level and speech identification scores and effect of age on speech identification scores would be used to evaluate speech perceptual ability in children and adults whose language age is low.

The same material could be used to evaluate individuals with inadequate speech and mentally retarded individuals, provided their receptive language age lies between 3-6 years.

The test material can be used to develop and central auditor}' tests for Tamil speaking children such as dichotic monosyllabic tests or time compressed speech tests filtered speech tests, binaural fusion tests, etc.

It is hoped that, the developed test, would be useful in evaluating and fitting of hearing aid for children whose language age is between 3-6.6 years.

It can be used in the evaluation and rehabilitation of children with cochlear implants.

Finally, this may stimulate the desire to probe deeper, to know more and to develop and implement more speech identification tests in other Indian languages in future.

REVIEW OF LITERATURE

Speech was used as test material for hearing assesment as far back as two centuries ago. Ernand and Pereire in the middle of 18th century and Itard at the beginning of the 19th century used speech to evaluate the effects of auditory training on their patient's speech perceptual abilities (Urbant-Schitsch, *\%95).*

The characteristics of speech tests vary enormously in a large number of dimensions such as content, presentation and response modalities etc. When selecting a speech tests for some new purpose, there is a bewildering array of tests from which to choose. The choice may then depend on answering questions like :

Why are speech tests required ?

Should the test predict real life speech understanding?

Should the test compare two or more scores?

Should the test identify the specific phonemes the person cannot hear?

Should the test find the maximum score or the speech threshold?

From questions like these, selection of a list of attributes that the desired speech test should have, can be made. Selection of an appropriate test would be easier if the audiologist had a knowledge of all the available tests and their attributes. If no existing test comes close enough to the testers requirements, then modification of an existing test, or developing an entirely new one would be recommended.

Speech tests for children mainly evaluate a child's ability to make correct phonemic classification usually on the basis of acoustical information. Suchtests are commonly referred to as speech articulation tests, speech intelligibility tests, speech discrimination tests or speech recognition tests (Markides, **1978).** These tests have also been synonymously termed as speech identification tests.

The following section reviews attributes of speech tests which must be considered when selecting **a** speech tests (especially for children). The information is reviewed under the following headings :

A. Attributes of Speech Test Material
B. Attributes of Test Recording and Presentation Methods and
C. Dependent attributes of Speech Tests.

A. Attributes of **Speech Test Material**

a) *Redundancy and Context*

Due to its redundant nature, speech is a highly efficient means of communication, despite interferences and noise. This arises from the superfluity of rules in the system : phonological rules which constrain the occurrence of phonemes to form words, syntactic rules which govern the structure of sentences, and semantic rules which restrict the co-occurrence of words in a sentence. The rules facilitate speech reception by enabling the listener to make intelligent guesses when part of the acoustic signal is masked or missing.

The redundancy in speech can be exploited to construct speech test materials which range from those with negligible contextual information to those which contain all the redundancy inherent to real speech. At one extreme are tests comprised of nonsense syllables and sentences at the other end. The former have the least redundancy by the latter are highly redundant.

Material that is rich in contextual cues taps a subject's knowledge of the world, knowledge of the language and the ability to use contextual information to perceive speech, in addition to the auditory ability to hear and process acoustic cues. Materials with low redundancy and low context mainly tests the listener's ability to perceive acoustic cues. This is an important consideration especially when subjects may or may not have the requisite knowledge and linguistic and cognitive abilities (Dillon and Ching, 1995).

b. ***Acoustic Context***

The description of speech sounds could be done at two different levels namely the acoustic level and phonetic level. Acoustic level/analyses refers to the measurable properties of the speech waveform, such as fundamental frequency or presence of random excitation, formant-frequencies and amplitude . In phonetic description, sounds are classified into categories such as vowels, consonants, stops, fricatives, glides and nasals (Plant and Spens, 1995).

All phonetic contrasts are cued by a multiplicity of interacting acoustic cues. For eg. vowels are known to vary in terms of formant frequencies, amplitudes durations intensity and vowel quality difference (Plant and Spens, 1995).

The richness of acoustic context of the test item, on the number of cues present in an item, is related firstly to the phonetic context in which it is presented and secondly to the way in which it is recorded (Boothroyd, 1986). When the test material is presented in the same carrier phrase in which it was recorded, the co-articulation effects in phonemes adjacent to the test item can help identify the target (Lynn and Brotman, 1981). The enunciation of the speaker is known to affect the relative difficulty of a test especially when monosyllable were used (Lynn and Brotman, 1987).

Thus, in consideration with the above, it can be understood that the 'acoustic context' and 'phonetic contexts' which may range from phonetic contrast cues, enunciation of speech, recording to co-articulatory effects influence the subject in identifying the target. Hence a carful evaluation of these becomes very essential for construction of speech identification tests.

c. *Phonemic Balance*

Phonemic balance is normally measured separately for initial and final consonants, and is based only on the distribution of phonemes in monosyllables in spoken language. As such it is constrained by the phonological rules operating in the sound system, and is more aptly described as phonemic balance. A Phonemically balanced list is one in which all phonemes are represented in the list with the frequency of occurrence representative of everyday speech (Denes, 1965; Mines et aL 1978).

The rationale for using phonemically balanced test material is that if the listener were unable to perceive a particular phoneme which occurs infrequently in normal everyday speech, the handicap experienced is not as severe as it would have been had the phoneme been a more common one. But the relevance of precise fulfillment of phonemic balance in speech test material to predicting communicative difficulties in everyday life due to hearing loss is questionable (Dillon and Ching, 1995).

Test material having a reasonable proportional representation of the sounds that occur in everyday speech is said to be phonetically balanced (Egan, 1948). The necessity of phonetic balance has been questioned, and there is no agreement on this point. Tobias (1964) 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 patients and their phonetic distribution is appropriately diversified, one fifty words compilation is relatively equivalent to another".

d. *Visual Context*

There is growing appreciation of the crucial importance of visual information to speech perception, not only in hearing aid users but also in normal listeners, especially under less ideal listening conditions (Summerfield, 1983). Information arises from articulatory movements, other paralinguistic information such as facial expressions, sex, age, identity and attitude of the speaker is also conveyed. Many of the consonantal ambiguities in auditory perception can be resolved when visual clues are available (Walden et al., 1990).

e. *Word Familiarity*

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

Words which are encountered more frequently in real life tend to be recognized better in speech tests than words which are not. The familiarity of a word obviously needs to be viewed in the context of the people whom test is to be administered. Children who have a profound hearing loss since birth will usually have a much narrower vocabulary than normal hearing children of their own age. Myklebust (1964) compared reading vocabulary of school age children and reported higher scores for 9 year old hearing children than for 15 year old hearing-impaired children.

Owens (1961) reported "If the stimulus is familiar word, it is likely to be prominent among those competing response and is quiet likely to be chosen. On the other hand, if the stimulus has low familiarity, it is unlikely to be among the competing responses". Schultz (1964) showed a marked tendency for highly familiar words to be substituted for incorrectly identified words. Devaraj' s (1983) study on the effect of word familiarity on speech discrimination scores carried out on Indian English speakers is also in consonance with the above studies. In general, it is recommended that the test items should be familiar to the target population.

f. *Response set*

Speech tests are often categorized as open response or closed response. In open response format, the listener repeat verbally or write down the sound or words that they thought they heard. In a closed response format, listeners are presented with a list of responses from which to choose. Tests with four to six response alternatives are most common.

Miller et al. (1951) opined that as the size of the response set increased, responding becomes more difficult for the subject and scores decreased. It may be due to subject's short-term acoustic memory.

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

g. ***Number of items per list***

It is the primary determinant of test reliability and is thus one of the most important characteristics of a speech test (Dillon and Ching, 1995). Egan (1948) opined that the minimum number of monosyllable words required in each list to achieve a phonemic balance is 50. Tests are available which have varied number of items ranging from five [eg. Auditory Number Test, Erber,(1980)]to as many as 150 are more [(eg. CNC test, Peterson and Lehiste, (1962J The choice of these depend on the purpose of the test.

h. ***Number of lists***

In clinical applications, needs for a large number of lists is rare because clinical time constraints preclude a large amount of speech testing however, it is imperative to have a large number of experimental conditions in an experimental setting (Dillion and Ching, 1995). It is not uncommon to see tests having just one list [eg. Auditory Rhyme Test, (Fairbanks, 1958). CUD W-22 lists, (Hirsh et al. (1952)]. However, there exists tests that have as many as 20 lists (eg. PAL list of PB 50, Egan, 1948). According to Egan (1948) the lists should be equal in terms of average difficulty, range of difficulty and phonetic composition. If articulation curve of and individual is to be obtained then severe lists one required. It is important that the same list should not be used more than once, because the scores may be contaminated with memory and practice effects (Tillman and Carhart, 1963). Hence, Dillon and Ching (1995) have suggested the use of equivalent lists so that any item will be presented only once.

i) *Ability tested: detection, discrimination, recognition and comprehension.*

There are four basic types of responses that contribute to perception of conversational speech. They are detection, discrimination, recognition and comprehension (Hirsh, 1964; Boothroyd et al. 1971).

Detection is the ability to respond differently to the presence and absence of a speech stimuli (Hirsh, 1964-).

Discrimination requires a same-different response. It refers to the ability to perceive similarities and differences among two or more speech stimuli (Hirsh, 1964)-

Recognition is the ability to produce a speech stimulus by naming or identifying it is some way. It can be through pointing, writing, repeating etc. (Hirsh, 1964).

Comprehension is the ability to understand the meaning of language (Hirsh, 1964-).

Using speech stimuli, an individual's speech detection threshold, speech reception threshold and speech identification scores can be found. Speech detection threshold is the lowest level at which speech can be detected. While, speech reception threshold is the intensity level at which the listener can repeat 50% of the material presented. However, these measures do not talk about an individual's understandng of speech. The speech test which determines the listener's ability to understand speech under ideal listening situations are speech identification tests. Various other terms used analogously with speech identification are articulation, discrimination, intelligibility, understanding, perception and recognition (Penrod, 1994).

Besides the attributes of the test material, the way it is presented also affects the outcome of the results.

B. Attributes of Test Recording and Presentation Methods

a) *Response Method*

The subjects can indicate their perceptions in several ways. Most commonly, the subject verbally repeats what they thought they heard. Alternately, the responses could be written down. The problem with the verbal response is, it might be misheard by the tester. However, written responses can still be problematic if the person has spelling errors leading to misinterpretation of his perception, thus leading to an erroneous scoring and moreover write down responses are limited only to the literates. In critical applications, the subjects' response can be videotaped, and a second tester can transcribe the response.

Responding is simpler for closed response set tests. The subject can indicate the number of the chosen response, or can point to it. In some cases, the test items can be presented as pictures, to which the subject points, so that the test subject does not need accurate speech production. For tests administered on computer, the pointing can be via a touch sensitive screen, or done with a mouse or keyboard. It is possible for response biases being introduced by the spatial arrangement of the response foils, but this can be controlled by rearrangement of the foils when multiple testing with the same foils is used (Plant and Spens, 1995).

Whatever might be the response method, it must be remembered that speech tests of hearing should investigate the listeners high function not their speech production on their mental, physical, linguistic or educational abilities (Martin, 1987).

b) *Quantity Scored*

Speech identification tests, measure and express the scores in a variety of ways. For a monosyllabic word test, for eg. the items can be scored as proportion of words correct or as proportion of phonemes correct. The disadvantage of phoneme scoring is that it places additional demands on the concentration of the tester. Another scoring method is to count the complete sentences as items. This occurs when the response task requires the subject to follow an instruction or answer a question and when the subjects actions are then judged as either right or wrong. Alternatively, increasing the number of items into units even smaller than phonemes by counting the number of distinctive features by which the stimulus and the response differ can be used (McPherson and Pang-Ching, 1979).

Feeny (1990) has shown that this increased number of items improves test reliability and provides additional information about the errors made.

c. *Quantity Expressed: Percent Correct vs. Threshold*

Frequently, the quantity counted (distinctive features, phonemes, words, sentences, etc) is also the quantity used to express the result of the test. The percentage of speech units correct is the most appropriate way to express the results whenever the purpose of the speech test is to find the maximum achievable scores, or the score obtained under some specified conditions, such as a particular presentation level and/or signal to noise ratio (SNR). For many applications, however, it is more useful to find a speech threshold. That is, the speech level or SNR at which some specified level of performance (such as 50% correct) is achieved (Plant and Spens, 1995).

d. *Method of Level and SNR Adjustment*

The level of an item in a speech test is normally controlled in some way. The crudest method is for the talker to be instructed to speak with 'normal vocal effort' for all items. A slightly more sophisticated method is to provide the talker with a SPL monitor while the recording takes place. More recently, leq measurement has become easy to do and is more reproducible than watching a moving Vu needle. Leq refers to equivalent continuous level, and is equal to the level of a constant intensity sound which has the same intensity as the average speech item intensity. For both the Vu and Leq methods, the resulting level is much more influenced by the level of vowel than by the level of consonants in the item (Dillon and Ching, 1995).

e. ***Spectral Characteristics of Signal and Noise***

Information about speech is potentially available to a subject whenever the power of the speech in a frequency region exceeds both the subjects thresholds in that frequency region and the power of any masking noise or competing signal in that frequency region. Consequently, the spectral shape of the signal and any masking noise are key attributes of a speech test (Danhauer et al. 1985).

f. ***Live voice vs. Recordings.***

Clinicians sometimes speak the test materials themselves, presumably either because it is considered more interesting for the client or because the client will need visual cues to be able to attain a satisfactory score. Unfortunately, the results obtained will depend on who is doing the talking (House, et al. 1965; Penrod, 1979; Hood and Poole, 1980). Even for a particular talker, the manner in which speech sounds are produced can affect the score obtained (Brandy, 1966). Random variation in the intensity or clarity of enunciation will thus decrease test reliability.

ASHA (1988), proposed recorded voice to be a preferred method for stimulus presentation. Despite the advantages ofrecorded material Olsen and Matkin (1979), found that almost 65% of the 281 respondents they surveyed employed monitored live vocie for testing word recognition ability. From the above study it is evident that in busy clinical setting, monitored live voice is preferred to recorded speech tests.

Recorded tests can be edited to ensure uniformity of presentation level, can be standardized with normal hearers to ensure that all items have been correctly produced by the talker, and their acoustic characteristics can be analyzed. But the problem with the recorded tests is that signals cannot be presented at a pace that is consistent with the subject's response time and it cannot be repeated. These pose major hinderance when evaluating chidlren and difficult to test population. The use of interactive video laser discs coupled with adaptive presentations can make recorded stimuli suitable even for small children (Dillon and Ching, 1995). Computerized speech material overcomes the disadvantages of both the recorded and monitored live voice speech tests.

g) *Computerized Speech Audiometry*

Wittich et al. (1971), used computers to perform speech audiometry which involved simple controls over signal presentation levels. Using computrized speech audiometry, signals can be presented at a pace that is consistent with an individual's response time and can be repeated with ease. These advantages are especially useful while evaluating children and difficult to test population. Advantages of using a computer for speech audiometry include :

i) Digital represntation of signals therefore do not deteriorate over time,
ii) Sophisticated alternation such as time compressions, can be made relatively easy.
iii) Inter-laboratory consistency will improve substantially.
iv) Stimulus presntation can be easily randomized by the computer.

It can be concluded that presentation using computer incorporates the advantages of both live voice and recorded speech tests.

C. **Dependent Attributes of Speech Tests**

The above lists of attributes all represent more or less independent choices which the tester can make when choosing, designing or using a test. The following represent the consequences of the attributes already discussed for eg. choosing a certain reliability is difficult because it is the unavoidable result of other factors, the most important of which is the number of items per list. Similarly, other dependent attributes which are out of the reach of the tester are list equivalence, difficulty range within the lists, scope of the performance intensity function, validity and sensitivity. These can be still controlled to some extent by adopting suitable procedures while constructing the test.

The first part of this chapter discussed the attributes of speech test which should be considered by an examiner before opting for a test of his choice or designing a new test for a specific purpose. The next part in this chapter gives the summary of different speech tests for adults and children, arranged chronologically and categorized broadly based on the set of attributes discussed above. It also contains a brief review of various speech tests developed in India for both adults and children.

Summary of Tests on Phoneme and Word Perception

Part I: * Summary of Tests on Phoneme and Word Perception for Adults.

* AH the test measures "Speech Identification Scores" (SI) or "Speech Discrimination Scores (SO)
* O = Open set; C = Closed set; R = Repeat; MC = Multiple Choice ; ^Yes; X = No.
  W = Words ; PP = Picture Pointing; MR = Mark on Response sheet;
  P = Phonemes; CVC = Consonant Vowel Consonant; PB = Phonetic/Phonemic Balance : 1 = Phonetic Balance
  2 = Phonemic Balance

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
1.	Psychoacoustic Laboratory List PB 5O.Egan, 1948.	Reasonably common mono-syllable words	1	Monosyllable words in carrier phrase	O	R	SI	W=50	20	It is one of the test which has more than one list. There is interlist variabilities between the lists.
2.	CIDW-22. Hirsh.et al, 1952,	Monosyllabic words	1	CVC words in isolation	O	R	SI	P=150 W=50	4 4	Maximum intelligibility score was reached at 60 dB SPL. Hirsh, 1952.
3.	Rhyme test Fairbanks, 1958.	Words drawn from 250 common word list	X	Words in isolation	C	Insert missing sound in the word frame.	SI	P=50	1	
4,	CNC.Peterson & Lehiste, 1962.	Monosyllabic words	1	CVC in isolation	O	R	SI	P=150 W=50	10	

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
5.	NU-4. Tillman, Carhart and Wilbur, 1963.	Monosyllabic words	1	CVC in isolation	O	R	SI	P=150 W=50	2	"Almost perfect discnminaiion was obtained at +24 dB SL". Tillmanetal. 1963.
6.	NU-6, Tillman & Carhart, 1966.	Monosyllaic words	1	CVC in isolation	0	R	SI	P=150 W=50	4	*Asymptote was obtained at 32 dB SL. Tillman et al. 1966. *Malini(1981). Studied the interilst difference using form A of NU-8 on Indians, She found statistically significant difference between lists at low and high SL's.
7.	Modified Rhyme Test. House etal. 1965.	Monosyllabic words	X	CVC.CV in isolation	C e cnoice	MR	SI	P=50	6	Krueletal. (1969) employed MRT to find out the effect of speaker variability in testing, they found no difference with re-utterance by a given speaker.
8.	AB Isophonemic word test. Boothroyd, 1968.	Monosyllabic words	X	CVC words in isolation 10 vowels 20 consonants	O	R	SI	P=30 W=10	-	it Is specifically designed to evaluate speech identifica- tion ability of mild to severe adult SN loss individuals.
9.	Cuny nonsense syllable test. Levitt & Resnick, 1978.	Nonsense syllbles	X	CV.VC in carrier phrase	C /toa cnoice	MR	SI	p=55		In this the vowels used are /a/ /// and /u/ with different consonants of varied place and manner. The voicing contrast are randomized.

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
10,	Iowa vowel recognition test. Tyler etal, 1983-	Mono syllabic words	X	/h v d/	C 9 choice	R	SI	P=45	6	The inter consonantal vowel used are /i/ /e/ /// /u/ /o/, all of these vowels are used in a random order.
11.	Speech Pattern Contrast test. Boothroyd, 1984.	Speech pattern carried by meaningful phrases	X	3 word phrase with different	C 3 choice	MR	SD	p_12	4	* This test is specifically developed for post lingually deaf of age >9 years. SPAC also uses meaningful phrases with suprasegmentai contrasts.
12.	THRIFTCA three intreval forced choice test of speech pattern contrast perception) Boothroyd, 1986	Speech patterns carried by pure tones.	X	Synthetic tokens for long short distinctions	C 3 choice	MR	SD	Duration Score = 24	4	This test is applied to generate a profile of an individual's access to several phonologically significant sDeech pattern contrast. It
		Speech patterns carried by synthetic vow		Synthetic consonant or changing Fo patterns on /ah/ and /oh/	C 3 choice	MR	SD	intonation Score = 24		measures the amount of sensory evidence that the subject obtains from the speech, regardless of such
		Nonsense syllables	X	CV & VC in isolation	C 3 choice	MR	SD	p-24	4	things as current age, age at the onset of deafness, listen ina experience, motor speech skills and language develop ment.
13.	FAAFCFour Alternative •Auditory Featuire Test) Foster & Haggard,1987.	Monosyllabic words	X	CVC in a carrier phrase.	C * choice	MR	SI	W=80	5	

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Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
14.	Cunny Modified NST. Gelfand etal,1992.	Nonsense syllables	X	CV, VC in isolation	C	MR	SI	P=38		Levitt and his co-workers made no attempt at phonetic balance but were more concerned with the most frequent perceptual confusions made by both normal hearing listeners (Miller and Nicely, 1955 and Wang and Bilger, 1973) and hearing impaired listeners (Owens, Benedict and Schubert, 1972).

Part II :Summary of Tests on Phoneme and Perception For Children.

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
1.	Kendall Toy Test. Kendall, 1953.	Monosyllabic words	X	Monosyllabic words in carrier phrase	C 10 choice	Object pointing	SI	W=10	3	Kendall (1953), added an additional 5 toys to lessen the chance response.
2.	Phonetically Balanced Kinder-garten PBK. Haskins, 1964.	Monosyllabic words	1	Word in isolation	O	R	SI	P=150 W=50	4	Sanderson-Leepa and Rintlemann (1978), found that PBK 50 does not yield maximum word identification scores.

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
3.	Word intelligibility by picture identification (WIPI) Ross & Lerman, 1970.	Monosyllabic words	X	Words in carrier phrase	C 6 choice	PP	SD Though it is called 'SD' the abilitv actually measured is sı	W=25	4	* Sanderson-Leepa and Rintlemann (1976), opined that use of WIPI is most appro priate for youngsters with a receptive age OT >4 years. •Hodgson (1973) compared WIPI and PBK 50 on normal children. WIPI showed greater scores.
4.	Nonsense syllable Test. Edgerton &Danhauer, 1975.	Monosyllabic words	X	CV&VC *v-/I/ . /a/. /u/*	C	MC	SI	9 syllables	7 modeules	*Danhauer etal.1984 used NST in assessing children's perception; * Butts etal.1987, compared the errors on an NST to puretone threshold and found excellent predictive relations.
5.	Monosyllabic Trochee and Spondee Test (MTS).Erber and Alenwicz, 1976.	1-2 syllable words	X	Mono/disyllabic words in carrier phrase •	C 12 choice	PP	SI	W=12	1	

Sl. NO.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
6.	McCormick Toy lest.MccormicK,	Monosyllable words	X	Monosyllables in carrier phrase	C	Finger pointing	SI	W=12	1	Ousey et al. 1989; Palmer. Sheppard and Marshall, 1991 gave automated version which is highly refined and accurate for obtaining stable and repeatable automatised speech test results.
7.	Auditory Number Test. Erber, 1980.	Numbers	X	Single No. or nos. in sequence	C 5 choice 11-5J	PP	SI	W=5	1	Erber (1980), reported that this test showed hiah test-retest reliability and can be used for rapid evluation of speech perception in young hearing impaired children.
8.	North-Western university - unnaren s perception of speech. (NU-CHIPS) Elliot	Monosyllaic words and Katz ,1980.	X	Monosyllabic words in carrier phrase	C 4 choice	PP	SI	W=50	4	This is meant for children **till** 10 years. Katz and Elliott. 1980 stated that the same test can be used with children as young as 3 years of age.
9.	Paedlatric speech intelli gibility test. Jerger	Monosyllables	X	Words in carrier phrase	C 5 choice	PP	SD	W=20	1	
10.	Glendonald Auditory screening procedure. Erber, 1982.	Monosyllables Trochies spondee, trisyllable Words	X	Words in isolation	C	PP	SD	W=24	1	A version with sentence and questions is also available.

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	comments
11.	PLOTTTest. Plant, 1984	Sounds in isolation	X	11 vowels & 11 consonants in isolation	C 2 choice	Yes/No response by pointing	SD	P=22	1	
		Numbers	X	Nos.1-5	C 5 choice	PP	SD	W=5	1	
		1-3 syllable words	X	3 of each mono, trochee spondees & 3 syllable words in carrier phrase.	C 12 choice	PP	SD SI	Stress pauern	1	
12.	Early Speech Peception (ESP), Moog & Geers, (1990)	Speech pattern 1-3 syllable words	X	3 each of mono spondee.trochee & 3 syllable	C 12 choice	PP	SD	W=24	1	It has two parts viz. (a) Standard version and (b) low verbal version. The low verbal version is meant for 2-3 years old hearing impaired children and the standard version is for 4-5 year old hearing impaired children.
		Spondee words	X	Spondees with differing vowels & consonant in isolation	C 12 choice	PP	SI	W=24	1	
		Monosyllabic words	X	Monosyllabic words beginning with /b/ & ending in a plosive.	C 12 choice	PP	SI	W=24	1	They categorize the children into 4 as (a) No pattern perception (b) Children with pattern perception (c) children with some word identification, and (d) Children who can identify words even when the vowels are pretty similar.

2.23

Sl. no.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
13.	Toy test for who have English as a second language. Bellman &Marcuson, 1991.	Monosyllbles	X	Carrier phrase	O	Pointing	SI	6	2	It was standardized for 2-6 year old children of the Indian subcontinent who speak English as a second language It is also referred to as "E2L toy test".

Part Ⅲ :Summary of Tests on Phoneme and Word Perception In Indian Languges.

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
1	PB word list in Hindi. Abrol, 1911.	Monosyllables	1	Monitored live voice	O R		S I	100	1	This test was standard izedby-the author in All India Institute of Medical Sciences, New Delhi.
2.	Speech percep-tion test in Tamil and Telunu Kaour. 1971.	Bisyllables	1	Recorded	O R		S I	50	1 for each language	Horiguiti (1966) in an analysis of-discrimina tion tests in various languages mentioned that the test can be constructed on poly syllabic words occuring proportionally in the

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	No.of List	Comments
										language when mono syllabic words were limited. Since monosyl labic words are limited in Tamil and Telugu, bisyllabic words were used.
3.	Di syllabic Speech test in Malayalam. Kapur,1971.	Bi syllables	1	Recorded	O	R	SI	34	1	Maximum score of 97 was obtained at 45 dB (re.audiometric zero).
4.	Standardization of speech tests in English for Indians. 1972.	Monosyllables	1	Recorded	0	R	SI	25	2	A spondee list was also constructed which evaluated SRT responses were obtained at 40-45 dB SL (re. PTA).
5.	Synthetic speech identification test inKannada. Nagaraja, 1977	Sentences	X	Synthetic sentences	C	Pointing	SI	10 1st order sentences 20 2nd order	2	It was observed that the performance increase till 45 dB SPL and remains constant thereafter at 0 db MCR.
6.	A common speech discrimi- nation test for Indian languages. Mayadevi, 1974.	Nonsense syllables	X	Recorded CV combinations	O	R	SI	20	6	It is standardized for both normal and clinical population. It serves as a common test list for Kannacte, English, Hindi, Telugu.Tamil, Malayalam, Tulu, Urdu, Coorgi, Gujarathi, Marathi, Konkani & Santoni.

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Response Method	Ability tested	No.of item/lists	NO.Ot List	comments
7.	Phonetically balanced test material in Tamil language. Samuel , 1976.	Monosyllables	1	Recorded	O	R	SI	25	4	Maximum scores is obtained at 35dB SL.
8.	NU Auditory Test No .6 in English on Indian speakers. Malini,19 81.	Monosyllables	1	CNC monosyllables	O	R	SI	50	4 Form A of NU 6	CID W-1 list was used to estimate the SRT, which served as ref. for PB testing.
9.	A picture test of speech perception in Malayalam. Mathew,1996. >	Bisyllables	2	Monitred live voice witn carrier pnrase	C	PP	SI	50	4	Mathew (1996) also developed half lists for the same test. It was developed in the same format as that of NU CHIPS but this test has only one picture book.
10.	Perception of monosyllabic words in Indian children. Rout, 1996.	Monosyllables	2	Monitored live voice witn carrier pnrase	C	PP	SI	50	4	Rout also developed 2 half lists for the same. It is developed in the same format as that of NU CHIPS but it has only one picture b6ok.
11.	Speech identi-fication test for Kannada speaking children. Vandana, 1998.	Bisyllables	2	Monitored live	C	PP	SI	50	4	Vandana also developed 2 half lists for the same It is developed in the same format as that of NU CHIPS but it has onlyone picture book.

2.25

Speech Reception Threshold Tests for Children.

Sl. No.	Test Name	Linguistic	PB	Acoustic	Response Set	Method	Ability tested	No.of rtem/liste	No.of List	Comments
!	A Picture SRT test for adults and children in Kannada. Rajashekar, 1976	2-3 syllable words	X	Recorded	C	PP	SI	16	4	It has black & white pictures and it was standardized for 3-5 year old children. It also had standardized list for adults (17-25 years).
2	pictrure speech reception threshold for children in Kannada. Hemalatha,1981.	Polysyllabic words	X	Recorded	c	PP	Reception	20	2	It was standardized for children in the age range of 4-8 years.

2.26

METHODOLOGY

The aim of the present study was to construct a phonemically balanced and standardized "Picture Speech Identification Test in Tamil for Children". The test is intended for Tamil speaking children in the age range of 3 years to 6.6 years. The test -involves a picture pointing task.

The study was done in two stages viz.
Stage 1 - Pilot study
Stage 2 - Main/Normative study

Stage 1 : The Pilot Study

Subjects :

This involved ten subjects. The criteria chosen for selection of subjects were as follows:

(i) All subjects should be native speakers of Tamil and should be well exposed to the language at least in the home environment.
(ii) They should be within the age range of 3-6 years.
(iii) They should have no complaint of any hearing-impairment.
(iv) They should not have any history of an otological, neurological, psychological or opthalmological language problem.
(v) They should have normal speech, language and motoj milestones.

Development of Test Material:

To develop the test material, picturable bisyllabic Tamil words which were within the vocabulary of 3-6 year old children were selected from -

(a) Text books and picture books meant for the above age group.

(b) Parents of Tamil speaking children *in* the above age group.

A total of 120 words were listed. These were further short listed to 90 unambiguous picturable bisyllabic words. These picturised words were then subjected to a pilot study.

Procedure for Pilot Study

The ninety words were subjected to a test of familiarity on ten children (four in the 3-4 year group, three in the 4-5 year and the 5-6 year group) in the Pilot Study.

Each subject was tested individually, were they were asked to name the picture depicting the items of the word list. A word was retained only if 90% of the children could name and identify the picture correctly. Sixty-three words were found to be familiar.

Construction of the Test Material

Out of the sixty-three familiar words, fifty words Were taken as test items, another three words were utilized as practice items. The rest were used as distractors.

The test items were chosen, so as to achieve a phonemic balance. The frequency of occurrence of a phoneme in Tamiltras based on the data published by Ramakrishna et al. (1962).

Four lists of words viz, A, B, Al and Bl were constructed with fifty tokens each. List B had the same words as in list A but in a different random order. The words in list Al and B1 were in the reverse order of the lists A and B respectively (Appendix I).

For each of the lists, a half list was constructed. The phonemic balance was maintained for both the full and half lists.

A test kit which contained a picture book and scoring sheets was developed. It contained three pages for practice items which were not a part of the test. The picture book was made in such a way that the same book could be used for both the test forms.- Each page in the book had four pictures, among which one was the test item and the others were distractors. The distractor words had any one phoneme or final syllable which rhymed with the test word (Appendix IV).

The score sheet contained the test items of each test form and the quadrant of the picture foil in which the correct items were located :

Quadrant I refers to picture in upper left
Quadrant II refers to picture in upper right
Quadrant III refers to picture in lower left
Quadrant IV refers to picture in lower right

It also contains a space for noting pertinent information about the patient (Appendix II).

Stage 2 : Normative Study

Subjects :

Forty children who satisfied the criteria mentioned in the pilot study were selected. These children were not includd in the pilot study. In addition these children were tested to ascertain that their hearing was within the normal limits. Ten children were selected in each group, viz. 3-3.11 years, 4-4.11 years and 5-5.11 years and 6-6.6 years. These children were chosen from varied cultural and socio-economic background, all residing in the urban city, Mysore (Karnataka) but speaking Tamil (motter tongue) at homes.

Instrumentation :

A two channel, clinical diagnostic audiometer, Madsen OB 822 with TDH 39 earphones housed in circumaural ear cushions MX 41/AR and a bone conduction vibrator B71 were used for testing. The audiometer had facilities for testing air conduction, bone conduction and speech audiometry. The calibration of frequency and intensity for puretones and speech was done to confirm to ANSI, 1989 specifications. Calibration of frequency and intensity was also done for BC vibrator (Appendix V). Stable power supply to the instrument was ensured by a servo controlled voltage stabilizer.

Test Environment:

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

***Data Collection* :**

Data collection was carried out in the Department of Audiology at All India Institue of Speech and Hearing, Mysore. Before the speech testing was done, the children were subj ected to a puretone testing for both air conduction and bone conduction from 250 Hz through 8 kHz and 250 Hz through 4 kHz respectively. The better ear was considered as the test ear for speech evaluation for each subject.

Instructions :

The subjects were given instructions in Tamil in the following way :

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

Administration of Speech Identification Test:

A minimum of two examiners were required to carryout the test. One examiner presented the stimuli using monitored live voice ensuring the deflection of the VU meter to zero. A distance of 6-9 inches was maintained between the microphone and the mouth of the speaker as recommended by Penrod (1994). The other examiner sat beside the child to help him or her turn to the appropriate page of the picture response book.

Initially three practice items were presented at a comfortable level i.e. 40 dB SPL relative to Fletchers Average [the average of two better thresholds among the speech frequencies, 500, 1000 and 2000 Hz(Rupp and Stockdell, 1980)].

Later, the tests were administered at 10 dB SL, 20 dB SL, 30 dB SL and 40 dB SL relative to Fletcher's Average. Each subject was presented list A and list B (Appendix I) for two of the two intensity levels. The same two test forms were presented in the reverse order for the other two intensity levels. Both the order of the test forms and level of presentation were randomized using a random table (Linquist, 1970). No child heard the same list or presentation level more than once.

Scoring :

The response were recorded on a score sheet. Correct responses were given a score of two and incorrect responses were given a score of zero. The percentage of correct responses were calculated for each subject.

Statistical Analysis

The data collected for forty subjects were subjected to statistical analysis.

RESULTS AND DISCUSSION

The present study aimed at developing and standardizing a picture speech identification test in Tamil for children. Forty normal (speech and hearing) children in the age range of 3-6.6 years, whose mother tongue was Tamil were evaluated. The study was carried out to obtain the following information:

1. The effect of presentation level on speech identification scores.
2. To check the inter-list variability.
3. Whether the half list is equivalent to the full list.
4. The effect of age on speech identification scores.
5. The effect of gender on speech identification scores.
6. Error analysis of the test items at 40dB SL (Ref.FA).

The data collected on the subject were statistically analysed. For each of the variables measured, the means and standard deviation were computed. To obtain significance of difference of mean, ANOYA. was done. Statistical analysis was done with the help of computer based statistical package: NCSS i.e. Numerical calculations for social sciences 5X series (Jerry, 1982-1992).

1. The Effect of Presentation Level on Speech Identification Scores :

The test materials were administered at four presentation levels viz. 10 dB SL, 20 dB SL, 30 dB SL and 40 dB SL relative to the Fletcher's average.

Results and Discussion of Mean and Standard Deviation

Table 1 and Fig. 1 reveal that there was least speech identification scores at 10 dB SL and greatest at 40 dB SL relative to the Fletchers Average. The deviation from the mean was greatest at 10 dB SL and least at 40 dB SL relative to the Fletchers average. This indicates a steady increasing trend in the performance with increase in presentation levels. This could be attributed to the greater acoustic energy available to the subjects at a higher presentation level. The above findings are in consonance with Tillman (1965), Carhart (1965), Swarnalatha (1972), Mayadevi, (1976), Elliot and Katz (1978), Malini (1981), Rout (1996), Mathew (1996) and Vandana (1998). All these investigations obtained maximum scores at 30-40 dB SL. However, Hirsh (1952) achieved the maximum scores at 60 dB SL for CID-W22 word list. This could be due to difficulty of the test item administered.

The mean and standard deviations of the speech identification scores for all 40 children across four presentation levels are depicted in Table 1.

Presentation Level	Count	Mean	S.D.	Minimum -	Maximum
10 dB SL	40	91.55	6.428	96	100
20 dB SL	40	95.9	4.124	84	100
30dBSL	40	98.2	2.430	90	100
40 dB SL	40	99.3	1.539	94	100

Table-1 : *Mean and Standard Deviation of speech identification scores across different presentation levels.*

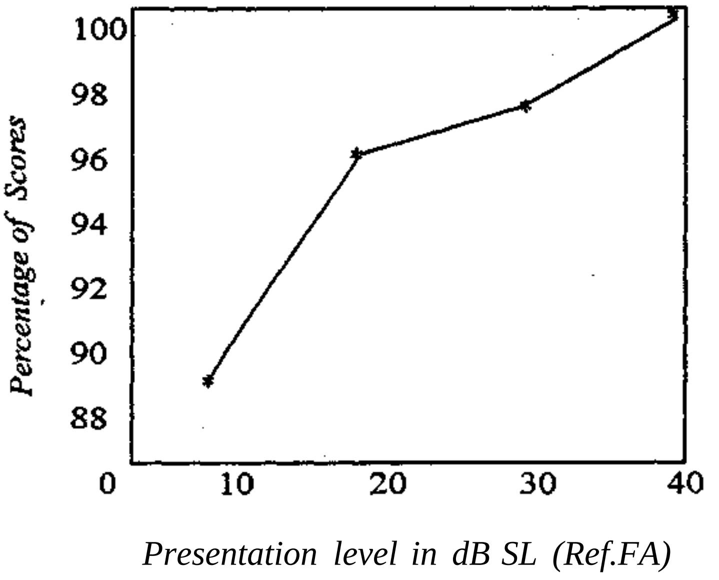


Fig. 1 : Performance intensity function (Articulation curve).

Results and Discussion of Analysis of Variance

Analysis of variance was done to find if there are any significant difference in the mean test score across the presentation levels (Table 2),From Table-2 it can be inferred thatthere exists a highly significant difference in the mean test scores across the presentation levels [F (3, 156) = 28.27; P=2.66 Significant at .05 level].

Source	df	Sum of square	Mean Square	F-test	P-value
Between subjects	3	1412.675	440.891	28.27	at 0.5 level = 2.66
Within subjects	156	2598.3	16.657		F>P
Total	159	4010.97			

Table 2: *Summary ofANOVA findings across presentation levels*

Based on the findings of the present study and that of studies carried out by Rout (1996), Mathew (1996) and Vandana (1998), it seems appropriate to administer the test at 40 dB SL relative to Fletcher's Average to generate subject's maximum response. This intensity is suggested since subjects get maximum score at this presentation level.

2. Half Lists vs. Full List

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 carryout the entire test.

Many researchers like Carhart (1965), Elliot and Katz (1980) recommend to use a half list in evaluating speech intelligibility. However, it is important that the half list should yield similar results as the full list. Hence the reliability of the half lists was evaluated.

Results and Discussion of Mean and Standard Deviation

Table 3 and 4 shows the mean and standard deviation of the speech identification scores for the 40 children for the 1st and 2nd half lists respectively. Table 5 shows the mean and standard deviation of the speech identification scores of the two half list and full list at 40 dB SL (refFA).

Presentation Level	Count	Mean	S.D.	Minimum	Maximum
lOdBSL	40	90.2	7.411	72	100
20dBSL	40	95.6	4.776	80	100
30dBSL	40	98.1	2.715	92	100
40dBSL	40	99.1	2.121	92	100

Table-3: *Mean and Standard Deviation of speech identification scores across different presentation levels for 1st half list.*

Presentation Level	Count	Mean	S.D.	Minimum	Maximum
lOdBSL	40	92.7	6.268	76	100
20dBSL	40	95.9	4.573	80	100
30 dB SL	40	98.2	2.709	88	100
40dBSL	40	99.6	1.215	96	100

Table-4 : *Mean and Standard Deviation of speech identification scores across different presentation levels for 2nd half list.*

Source	Mean	S.D
First half list	99.1	2.121
Second half list	99.6	1.21
Full list	99.3	1.5

Table-5 : *Mean and Standard Deviation of speech identification scores at 40 dB SLfor 2 Half list and Full list.*

The tables 3, 4 and 5 reveal no marked variations in the mean scores across the lists especially at 40 dB SL (Ref.FA). Also the small value of standard deviation reflects less variance. This ' indicates that the scores obtained through all the lists are fairly uniform.

Results and Discussion of Analysis of Variance

To find if there are any significant differences in the scores obtained through the different lists (2 half and full list), analysis of variance was done and Table 6 reveals the summary.

Source	df	Sum of square	Mean square	F-ratio	P-value
Between group	2	58.2166	29.108	1.05	at 0.05 level = 3.01
Within group	477	13191.38	27.65		F<P
Total	479	13249.59			

Table-6: *Summary of ANOVA findings across the lists.*

The results of analysis of variance revealed no significant differences between the two half lists. Also, the two half lists were not significantly different from the full list This indicates that either of the half lists may be used instead of the full list without affecting the outcome of the test results.

3. Effect of Age on Speech Identification Scores

The forty children involved in the study were categorized in to four age groups of 10 each. The Group I had children in the age range of 3-3.11 years, Group II 4-4.11 years, Group III 5-5.11 years and Group IV had 6-6.6 year old children. Table 7 and 8 shows the mean and standard deviation of the speech identification scores at 10 dB SL and 40 dB SL relative to FA respectively. The range is also given in the above tables.

Group	Count	Mean	SD	Minimum	Maximum
I	10	87.8	8.5088	76	98
II	10	88.6	4.6236	82	100
III	10	94.8	2.8968	90	100
IV	10	95.2	1.5936	94	100

Table 7: *Mean, Standard Deviation and Range of speech identification scores for 4 groups of children at 10 dB SL (Ref.FA)*

Group	Count	Mean	SD	Minimum	Maximum
I	10	98.4	2.2705	94	100
II	10	99.2	1.6865	96	100
III	10	99.6	0.8432	98	100
IV	10	100	0	100	100

Table-8: *Mean, Standard Deviation and Range of speech identification scores for 4 groups of children at 40 dB SL (Ref.FA)*

Results and Discussion of Mean and Standard Deviation :

From the tables 7 and 8 and Fig. 2 it can be seen that at both the presentation levels i.e. 10 dB SL and 40 dB SL (ref. FA), there was an increase in speech identification scores with age. Also the standard deviation decreased with age in both the presentation levels.

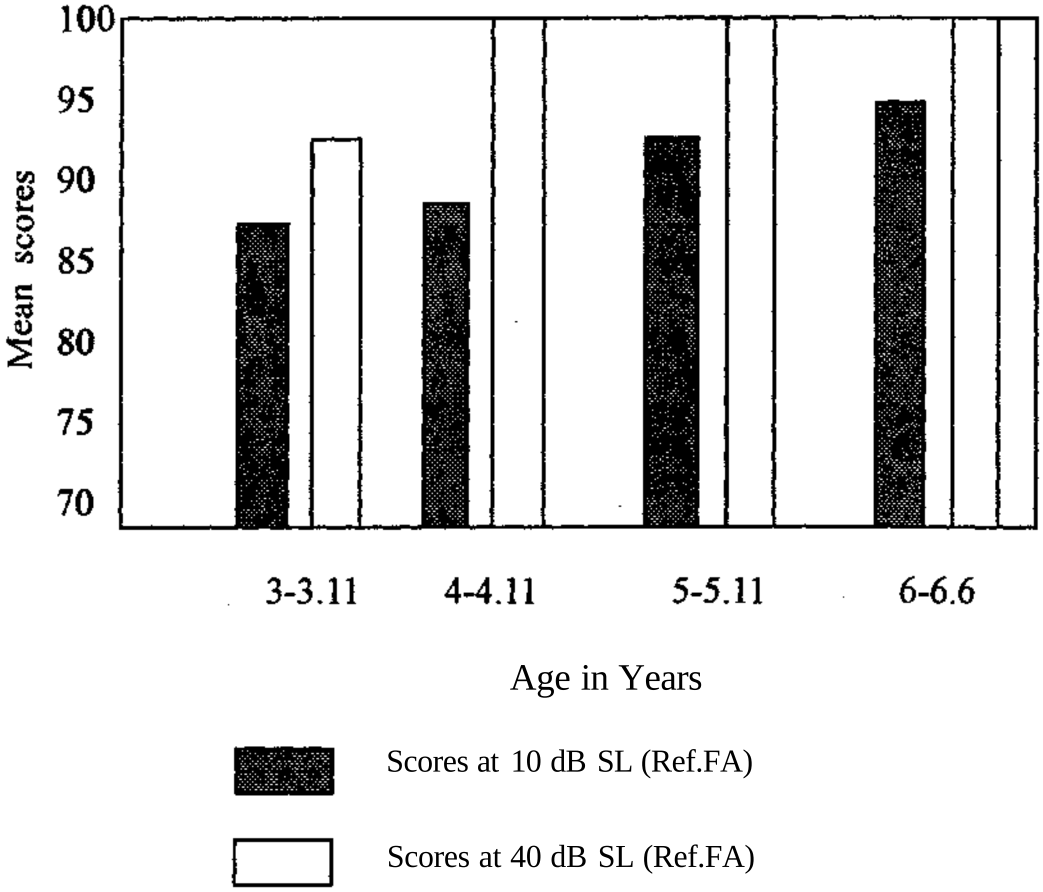


Fig. 2 : The mean speech identification scores for the 4 age groups at 10 dBSL and 40 dB SL. (Ref. FA)

It can be seen that with increase in age, the speech identification scores increased. Similar results were obtained when the presentation level were 20 dB SL and 30 dB SL (ref.FA).

Results and Discussion of Analysis of Variance

The ANOVA was established for the four presentation levels across the four age groups. With increase in age there was significant increase in speech identification scores for all presentation levels. Table 9 and 10 shows the summary of the ANOVA findings at 10 and 40 dB SL (ref. FA) for the 4 age groups.

Source	df	Sum of square	Mean square	F-ratio	P-value
Between group	3	466.4	155.47	4.67	0.0074 P > F
Within group	36	1199.2	33.31		
Total	39	1665.6			

Table 9 : *Summary of ANOVA findings at 10 dB SL (ref FA) for 4 age groups.*

Source square	df	Sum of	Mean square	F-ratio	P-value
Between group	3	14	4.67	2.14	0.1119
Within group	36	78.4	2.1777		P>F
Total	39	92.4			

Table 10 : *Summary of ANOVA Findings for 4 Age Groups at 40 dBSL (Ref FA)*

This is in concurrence with other studies done by Elliot and Katz **(I960);** Siegenthaler and Haspiel (1966); Ross and Lerman (1970); Mathew (1996), Rout (1996), and Vandana (1998).

4. Sex Difference In Speech Identification Scores :

Of the forty children considered in the study 29 of them were males and the remaining 11 were females. The mean, standard deviation and the range of the speech identification scores within the two groups was computed. These are shown in Table 11 and 12.

Group	Count	Mean	SD	Minimum	Maximum
Male	29	91.7931	6.48	78	100
Female	11	92.1818	7.18	76	100

Table-11: *Mean, Standard Deviation and Range of speech identification scores for two groups male and female (of all the age groups) at 10 dB SL (ref. FA)*

Group	Count	Mean	SD	Minimum	Maximum
Male	29	96.0689	1.27	96	100
Female	11	98.7272	2.05	94	100

Table-12 : *Mean, Standard Deviation and Range of speech identification scores for two groups male and female (of all the age groups) at 40 dB SL (ref. FA)*

The bar diagram in Fig. 3 depicts the mean speech identification scores for males and females at 10 & 40dB SL (Ref. FA).

The results revealed that females had higher mean speech identification scores at both the levels when compared to males. The standard deviation scores also showed a greater value for females than males indicating more dispersion of the scores.

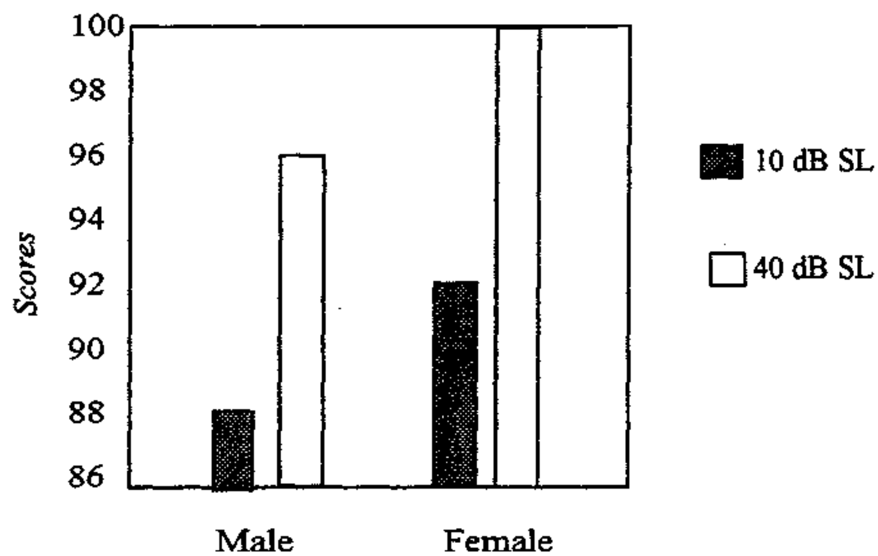


Fig-3. *Mean speech identification scores for males and females at 10 dB SL and 40 dB SL (ref.FA).*

This difference in scores could be attributed to the presence of more females in higher age group when compared to males. This evidently resulted in higher mean score of the female group in comparison to the male group. However, the mean difference between the two groups was less and did not prove any statistical significance.

5. Error Analysis

The stimuli and the corresponding responses for each subject at 40 dB SL (ref FA) were plotted on a confusion matrix (Appendix DDI) Analysis of the errors revealed that all the childen could identify the test item at 40dB SL (ref. FA). Most confusion occurred for a particular test item "Pa:nai (earthern pot). However, the test item satisfied the selection criteria (more than 90% of the subjects identified the test items) adopted for the development of test material which is detailed in the chapter "Methodology". Hence, the item was retained in the final test list. The probable reason for a consistent error on this item among the few could be attributed to three reasons :

a) Less common usage of the word in the dialect/cultural background of thd subjects tested.
b) Modernisation/cultural variation where usage of earthern pots are rarely evidenced.
c) Lack of the test word in the concerned subject's vocabulary.

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

1. With increase in age, the speech identification scores increased.
2. With increase in intensity, there was an improvement in the performance of the children.
3. The highest score was obtained at 40 dB SL (ref.FA)
4. The two half lists were found to be equal.
5. The two half lists were found to be equal to the full list
6. Females scored better than the males both at 10 & 40 dB SL.
7. All the children could identify the test item at 40 dB SL (*ef.FA) except for the word "pa:nai" (earthem pot). Since it was identified by more than 90% of the children, it was retained as a test item.

SUMMARY AND CONCLUSIONS

This study aimed at developing and standardizing a picture speech identification test in Tamil for children *in* the age range of 3-6.6 years.

The study aimed at evaluating the following :

1. The effect of presentation levels (i.e. 10 dB SL, 20 dB SL, 30 dB SL and 40 dB SL relative to Fletcher's Average) on speech identification scores.
2. The inter-list variability.
3. Whether the half list was equivalent to the full list.
4. The difference in the age of subjects and their performance in the test.
5. The difference performance of males and females on the same test.
6. Error analysis of the test items at 40db SL (Ref. FA).

The study was carried out in two stages, viz. Stage I and n. Stage I consisted of a pilot study where 10 subjects in the age range of 3-6.6 years participated. Stage II consisted of the normative study which had 40 subjects (subjects in the pilot study were not included) in the above mentioned age group.

The results of the present study showed:

1. When the test was administered to the subjects 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.

2. All the subjects obtained their personal best scores at 40 dB SL relative to the Fletcher Average. This is in agreement with the previous works reported in the literature (Ross and Lerman, 1970; Katz and Elliot, 1980;Malini, 1981:Rout, 1996;Mathew, 1996; Vandana, 1998).
3. The subjects performed equally well on both the half lists. This trend was seen across all the presenttion level
4. There was no significant difference between the half and full lists.
5. In the line of many researchers (Katz and Elliot, 19780; Siegenthaler and Haspiel, 1966 and Vandana, 1998), the present study also demonstrated an age related difference in the performance in the speech identification scores. There was statistical significant difference between the youngest (3-3.11 years) and the oldest (6-6.11 years) age group in this study.
6. The females performed consistently better than male subjects but also had a higher dispersion scores. This could probably be because most of the female subjects belonged to the upper age group.
7. An error analysis with the help of a stimulus response matrix revealed that all the children could identify the test item at 40 dB SL (Ref. FA). Errors were noticed in a particular test item "pa:nai" (earthern pot). Since it satisfied the test stimulus criteria (more than 90% of the subjects identified the test items), was retained in the final test list.

From the findings of the present study, the following recommendations are made :

1. It can be administered to children speaking different dialects of Tamil in the age range of 3-6 years.
2. To obtain the best speech identification scores, the test should be administered at 40 dB SL (ref.Fletcher Average).
3. For those children with shorter attention span, either one of the half list can be administered reliably.
4. The test can be used with older children or adult subjects who have inadequate speech and/or language skills.
5. The material developed can also be used for selecting amplification devices for paediatric and difficult to test population.
6. It is further recommended as an excellent tool for monitoring progress of an auditory training program.
7. The developed material can serve in evaluating and monitoring progress in cochlear implantees.

Recommendations for further research

In the line of the present study a few other research directions are indicated. These are :

1. It can be standardized on deviant populations such as : hearing impaired; learning disabled; childhood aphasics and mentally retarded subjects.

2. Compare the performance of deviant populations with age and language matched normal population. This would give a better insight into the understanding of speech perception/identification in deviant population.
3. To compare the performance of cochlear implant users vs. hearing aid users.
4. The test stimuli can be presented with a competing noise to stress the auditory system and the results can be compared with no-noise conditions. This would give an insight into the effects of noise on speech identification.
5. The whole test can be fed into a software and a computer based speech identification testing can be developed.
6. A larger normative study can be carried out and a 'neural network' based diagnostic package can be developed.
7. Audio recorded version of the same test can be developed and standardized, this can reduce the tester/examiner variability.
8. The four picture matrix can be changed to six picture matrix to decrease the chance factors.
9. Similar methodology can be adopted to develop and standardize speech identification tests in other Indian languages.

BIBLIOGRAPHY

Abrol, B.M. (1971). Cited in Nagaraja, M.N. (1990). Testing, Interpreting and Reporting Procedures in Speech Audiometric Tests. In S.K.Kacker & V.Basavaraj (Eds), Indian Speech Language and Hearing Tests - The ISHA Battery-1990.

ANSI : American National Standard Institute (1989). Specification for Audiometers. ANSI, 83,6-1989. New York: American National Standard Institute Inc.

ANSI : American National Standard Institute (1989). Maximum Permissible Ambient Noise for Audiometric Test Rooms. ANSI, 83, 6-1991. New York : American National Standard Institute Inc.

ASHA: American Speech-Language, Hearing Association Committee on Audiological Evaluation (1988). Guidelines for Determining Threshold for Speech. American Speech and Hearing Association, 30, 85-89.

Beasley, D., Maki, J. & Orchik, D.J. (1976). Children's Perception of Time Compressed Speech on Two Measures of Speech Discrimination. Journal of Speech and Hearing Disorders, 41,216-225.

Beasley, D., Schwimmer, S. & Rintelmann, W. (1972). Intelligibility of Time Compressed CNC Monosyllables. Journal of Speech and Hearing Research, 15, 340-50.

Bellman, S. & Marcuson. M (1991). A New Toy Tests to Investigate the Hearing Status of Young Children Who Have English as a Second Language : A Preliminary Report. British Journal of Audiology, 25, 312-32.

Bocca,E.&Calearo,C.(1963). Central Hearing Processes. In Jerger, J. (Ed.) Modern Developments in Audiology, New York : Academic Press.

Boolhroyd, A. (1968). Developments in Speech Audiometry. Sound, 2.3-10.

Boothroyd, A. (1971). In G.Fant (Ed). Speech Communication Ability and Profound Deafness. Washington, DC : A.G.Bell Association.

Boothroyd, A. (1984). Auditory Perception of Speech Contrasts by Persons With Sensorineural Hearing Loss. Journal of Speech and Hearing Research, 27, 134-44.

Boothroyd, A. (1986). Cited in Dillon, S.J. & Ching, T. (1995). Speech Perception and Testing. In G.Plant and K.C.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr Publishers Ltd.

Brandy, W.T. (1966). Reliability of Voice Tests of Speech Discrimination. Journal of Speech and Hearing Research, 9, 461-465.

Bunch, C. (1934). Cited in Martin, I.N. (1987). Speech Test for the Preschool Children, In F.N. Martin (Ed.). Hearing Disorders in Children (Pp.265-298). Texas : Pro-ed Inc).

Butts, F.M. (1987). Nonsense Syllable Test Results and Hearing Loss. Earand Hearing, 8, 1, 44-48.

Carhart, R. (1965). Problems in the Measurement of Speech Discrimination. Archives of Oto.Laryngology, 82, 253-260.

Clawson, J. (1966). Cited in Martin, F.N. (1987). Speech Test for the Preschool Children. In F.N.Martin (Ed.), Hearing Disorders in Children. Texas :Pro-ed. Inc.

Danhauer, J.L., Doyle, P.C. & Lucks, L. (1985). Effects of Noise on NST and NU 6 Stimuli. Ear and Hearing, 6, 266-9.

Devaraj, A. (1983). Effects of Word Familiarity on Speech Dsicrimination Score. Unpublished Masteral Dissertation, University of Mysore.

Denes, P.B. (1963). On the Statistics of Spoken English. Journal of the Acoustical Society of America, 35, 892-904.

Dillion, S.J. & Ching, T. (1995). Speech Perception and Testing. In G.Plant and K.E.Spens (Ed.). Profound Deafness and Speech Communication, (Pp. 3 05-344). London : Whurr Publishers Ltd.

Edgerton, B.J., Danhauer, J.L. & Sommons, F.J. (1986). Cited in Dillon, S.J. & Ching, T. (1995). What Makes a Good Speech Test? In G.Plant and KLE.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr Publishes Ltd.

Egan, J.P. (1948). Cited in Dillon, S.J. & Ching, T. (1995). What Makes a Good Speech Test? In G.Plant and K.E.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr Publishes Ltd.

Elliot, L.L. (1963). Prediction of Speech Discrimination Scores from other Test Infomation. Journal of Auditory Research, 3, 35-45.

Elliot, L.L. and Katz, D. (1980). Development of a New Children's Test of Speech Discrimination. St.Louis : Auditec. In F.Martin (Ed.), Hearing Disorders in Children. (Pp.265), Austin, Texas : Prof.Ed.Ine.

Erber, N. (1980). Use of Auditory Numbers Test to Evaluate Speech-Perception Abilities of Hearing-Impaired Children. Journal of Speech and Hearing Disorders, 41, 256-67.

Erber, N. (1982). Auditory Training. Washington, D.C : A.G. Bell Association.

Erber, N. & Alencewicz, C. (1976). Audiological Evaluation of Deaf Children. Journal of Speech and Hearing Disorders, 41, 256-67.

Fairbanks, G. (1958). Cited in Dillon, S.J. & Ching, T. (1995). What Makes a Good Speech Test? In G.Plant and K.C.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr-Publishers Ltd.

Fant, G. (1960). Acoustic Theory of Speech Production. The Hague : Mounton.

Feeny, M.P. (1990). Distinctive Feature Scoring of California Consonant Test. Journal of Speech and Hearing Disorders, 55,282-9.

Foster, N.R & Haggard, M.P. (1987). The Four Alternative Auditory Feature Test (FAAF) - Linguistic and Psychometric Properties of the Material With Normative Data in Noise. British Journal of Audiology, 21, 165-74.

Gelfand, S.A. (1975). Use of Carrier Phrase in Live Voice Discrimination Testing. Journal of Auditory Research, 15, 107-110.

Gelfand, S.A., Schwander, T, Levitt, H., Weiss, M. & Silman, S. (1992). Cited in Dillon, S.J. & Ching, T. (1995). What Makes a Good Speech Test? In G.Plant and K.C.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr-Publishers Ltd.

Ghosh, D. (1988). Development and Standardization of Speech Materials in Bengali Language. Unpublished Masteral Dissertation, University of Mysore.

Hady, W. & Bordley, J. (1951). Special Techniques in Testing the Hearing Children. Journal of Speech and Hearing Disorders, 16, 122-131.

Haskins,H.A. (1949). Speech Audiometry in the U.S.A. In Martin, Speech Audiometry. London : Whurr Publishers Ltd.

Haskins, H. A. (1964). Kindergarten PB Word Lists. In Newby, H. A. (Eds.). Audiology. New York : Appleton-Century-Crofts.

Harris, J.D. (1965). Puretone Acuity and Intelligibility of Everyday Speech. Journal of Acoustical Society of America, 37, 824-830.

Hemalatha, R (1981). Picture Speech Reception Threshold Test for Children in Kannada. Unpublished Independent Project, University ofMysore.

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 & Bensen,R.W. (1952). Cited in Dillon, SJ. &Ching,T. (1995). What Makes a Good Speech Test? In G.Plant and K.C.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr-Publishers Ltd.

Hirsh, I.J. (1964). In M.Martin, (Ed.). Speech Audiometry. London : Whurr Publishers Ltd.

Hodgson, W. (1973). Audiological Report of Patient With Left Hemispherectomy. Journal of Speech and Hearing Disorders, 32, 39-45.

Hood, J.D. & Poole, T.P. (1977). Improving the Reliability of Speech Audiometry. British Journal of Audiology, 11, 93-102.

Hood, J.D. & Poole, J.P. (1980). Influence of a Speaker and Other Factors Affecting Speech Intelligibility. Audiology, 19, 434-455.

Horiguin", Sinsak & Yamashita, Kouichi (1966). Cited in Kapur, Y.P. (1971). Development of Hearing and Speech Test Materials Based on Indian Languages. In Rathna, N. (Ed.). Speech Analysis in Indian Languages. Proceedings of a Seminar by Social and Rehabilitation Service of the Department of Health, Education and Welfare, U.S.A. under SRS Project No. 19-P-58134-F-01.

House, A.S., Williams, C.E., Hecker, M.H.L. & Kryter, K.D. (1965). Articulation Testing Methods: Consonantal Differentiation in Closed Response Set. Journal of the Acoustical Society of America, 37, 158-166.

Jerger, J. & Hayes, D. (1971). Audiological Manifestations of Lesions in the Auditory Nervous System. Laryngoscope, 70, 417-425.

Jerger, S. & Jerger, J. (1980). Paediatric Speech Intelligibility Test: Performance-Intensity Characteristics. Ear and Hearing, 3,325-334.

Jerger, J. & Jerger S. (1974). Auditory Findings in Brainstem Disorders. Archives of Otolaryngology, 99, 324-354.

Jerry, L. (1982-92). Numerical Calculations for Social Sciences. 5X Series, Utah.

Kapur, Y.P. (1971). Development of Hearing and Speech Test Materials Based on Indian Languages. In N.Rathna (Ed.). Speech Analysis in Indian Languages. Proceedings of a Seminar by the Social & Rehabilitation Service of the Department of Health, Education and Welfare, U.S.A., Under S.R.S. Project No. 19-P-58134-F.01.

Katz, D.R. & Elliott, L.L. (1978). Development of a New Children's Speech Discrimination Test. Presented in American Speech and Hearing Association. Chicago. In Rout, A. (1996). Perception of Monosyllabic Words in Indian Children. Unpublished Masteral Dissertation, University of Mysore, India.

Kendall, *D.C.* (1953). Audiometry for Young Children. Part-1 : Teacher of the Deaf. 51 : 171-8. Cited in Dillon, S.J. & Ching, T. (1995). What Makes a Good Speech Test? In G.Plant & KE.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr Publishers Ltd.

Kruel, KJ., Bell, D.W. & Nixon, J.C. (1969). Factors Affecting Speech Discrimination Test Difficulty. Journal of Speech and Hearing Research, 12, 281-287.

Levitt, H. & Resnick, S .B. (1978). Speech Reception by the Hearing-Impaired : Methods of Testing and the Development of New Tests. Scandinavian Audiology, 6 Suppl. 107-30.

Linquist, E.F. (1970). Statistical Analysis in Education and Research. Calcutta: Oxford and IBH Publishing and Co.

Luterman, D.M., Welsh, O.L. & Melrose, J. (1966). Responses of Aged Males to Time Altered Speech Stimuli. Journal of Speech and Hearing Research, *9*, 226-230.

Lynn, J.M & Brotman, S.R. (1987). Perceptual Significance of the CID-W-22 Carrier Phrase. Ear and Hearing, 2, 95-9.

Malini, M.S. (1981). Standardization of NU Auditory Test No.6 on English Speaking Indian Children. Unpublished Masteral Dissertation, University of Mysore, India.

Manorama Year Book (1996).

Markides,M. (1977). Hearing Aid Evaluation. In J.Katz (2nd Ed.). Handbook of Clinical Audiology, Baltimore, Williams and Wilkins.

Markides, A. (1978). Speech Discrimination Functions for Normal Hearing Subjects With AB Isophonemic Word Lists. Scandinavian Audiology, 7, 239-45.

Markides, A. (1979). The Effect of Content of Initial Instructions on the Speech Discrimination on Scores of Hearing Impaired Children. British Journal of Audiology, 13, 113-117.

Markides, A. (1980). The Relation Between Hearing Loss For Puretones and Hearing Loss for Speech Among Hearing Impaired Children. British Journal of Audiology, 14, 115-21.

Marshall, L. & Bacon, S.P. (1981). Prediction of Speech Discrimination Scores from Audiometric Data. Ear and Hearing, 2, 148-155.

Martin, F.N. & Forbis, N.K. (1978). In Martin, M. (Ed.) Speech Audiometry. London : Whurr Publishers Ltd.

Martin, F.N. & Pennington, CD. (1971). Current Trends in Audiometric Practices. American Speech and Hearing Association, 13, 671-677.

Mathew, P. (1996). Picture Test of Speech Perception in Malayalam. Unpublished Masteral Dissertation, University of Mysore, India.

Mayadevi (1974). Development and Standardization of Common Speech Discrimination Test for Indians. Unpublished Masteral Dissertation, University of Mysore, India.

McCormick (1977). Behvioral Hearing Test 6 Months to 3-6 years. In McCormick, E. (Ed.). Paediatric Audiology 0-5. Years. London : Whurr Publishers Ltd.

McPherson, D.F. & Pang-Ching, G.K. (1979). Development of Distinctive Feature Discrimination Test. Journal of Auditory Research, 19, 235-246.

Miller, G.A., Heise, G.A. & Lichten, W. (1951). Cited in Dillon, S.J. & Ching, T. (1995). What Makes a Good Speech Test? In G.Plant & K.E.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr Publishers Ltd.

Miller, G.A. & Nicely, P. (1955). Cited in King, A.B. Speech Perception Tests for Profoundly Deaf. In M.Martin (Ed.) Speech Audiometry. London : Whurr Publishers Ltd.

Mines, M.A., Hanson, B.F. & Shoup, J.E. (1978). Cited in Dillon, S.J. & Ching, T. (1995). What Makes a Good Speech Test? In G.Plant & KE.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr Publishers Ltd.

Moog, J.S. & Geers, A.E. (1990). Early Speech Perception Test for Profoundly Hearing Impaired Children. Central Institute for the Deaf, St.Louis, Missouri.

Morgan, D.E., Driks, D.D. & Bower, D.R. (1979). Sound Pressure Levels for Frequency Modulated Tones in the Sound Field. Journal of Speech and Hearing Disorders, 44, 37-54.

Myklebust, H. (1964). The Psychology of Deafness. New York : Grune and Stratton.

Nagaraja, M.N. (1977). Development of Synthetic Speech Identification Test in Kannada Language. Journal of All India Institute of Speech and Hearing, 8,11.

Olsen, W.O. & Matkins, N.D. (1979). Speech Audiometry. In W.F.Rintelmann (Ed.). Hearing Assessment. Boston : Allyn and Bacon.

Ousey, J., Sheppard, S., Twomey, T. & Palmer, A.R. (1989). The IHR - McCormick Automated Toy Discrimination Test - Description and Evaluation. British Journal of Audiology, 23, 3, 245-50.

Owens, E. (1961). Intelligibility of Words Varying in Familiarity. Journal of Speech and Hearing Research, 4, 113-129.

Owens, E., Benedict, M. & Schubert, E.D. (1972). Consonant Phonemic Errors Associated With Puretone Configurations and Certain Kinds of Hearing Impairment. Journal of Speech and Hearing Research, 15,308-22.

Palmer, A.R,Sheppard, S. (1991). Behavioral Hearing Loss 6 Months to 3.6 Years. In McCormick, (Ed.). Paediatric Audiology - 0-5 Years. London : Whurr Publishers Ltd.

Penrod, J.P. (1979). Talker Effects on Word Discrimination Scores of Adults With Sensorineural Hearing Impairment. Journal of Speech and Hearing Disorders, 44, 340-349.

Penrod, J.P. (1994). Speech Threshold and Recognition Discrimination Testing, In J.Katz (4th Ed.). Handbook of Clinical Audiology. Baltimore : Williams and Wilkins.

Peterson, G.E. & Lehiste, I. (1962). Revised CNC Lists for Auditory Tests. Journal of Speech and Hearing Disorders, 27, 62-70.

Plant, G. (1984). A Diagnostic Speech Perception Test for Severely and Profoundly Hearing Impaired Children. Australian Journal of Audiology, 6, 19.

Plant, G. & Spens, K.E. (1995). Profound Deafness and Speech Communication. London : Whurr Publishers Ltd.

Rajashekar, B. (1976) Development and Standardization of a Picture SRT Test for Adults and Children in Kannada. Unpublished Masteral Dissertation, University of Mysore.

Ramakrishna, B.B., Nair, K.K., Chiplunkar, V.N., Atal, B.S., Ramachandran, V. & Subramanian, R. (1962). Some Aspects of the Relative Efficiencies of Indian Languages. Ranchi India : Catholic Press.

Ross, M. & Lerrman, J.W. (1970). A Picture Identification Test for Hearing Impaired Children. Journal of Speech and Hearing Research, 13,44-53.

Rout, A. (1996). Perception of Monosyllabic Words in Indian Children. Unpublished Masteral Dissertation, University of Mysore, India.

Rupp, R-R. & Philips, D. (1969). The Effect of Noise Background on Speech Discrimination Function in Normal Hearing Individuals. Journal of Auditory Research, 9, 60-63.

Rupp, R.R & Stockdell, K.G. (1980). The Roles of Speech Protocols in Audiology. In R.R.Rupp and K.G.Stockdell (Eds.), Speech Protocol in Audiology. New York : Grune and Stratton, Inc.

Rupp, R.R. (1980). The Human Communicative Function. In R.R.Rupp and K. G. Stock Dell (Ed.). Speech Protocols in Audiology. London : Grune and Stratton, Inc

Samuel, J.D. (1976). Development and Standardization of Phonetically Balanced Materials in Tamil. Unpublished Masteral Dissertation, University of Mysore, India.

Sanders, D. A. (1982). Aural Rehabilitation Management Model (2nd Ed.). New Jersy : Prentice Hall.

Sanderson-Leepa, M.E. & Rintelmann, W.F. (1976). Articulation Function and Test-Retest Performance of Normal-Hearing Children on Three Speech Discrimination Tests. WIPI, PBK. 50, and NU Auditory Test No. 6. Journal of Speech and Hearing Disorders, 41, 503-519.

Schultz, M.C. (1964). Word Familiarity Influences in Speech Discrimination. Journal of Speech and Hearing Research, 4, 395-400.

Siegenthaler, B. & Haspiel, G. (1966). Development of Two Standardize Measures of Hearing for Speech by Children. U.S. Department of Health, Education and Welfare, Project No.2372. Contact No.OE-5-10-003.

Summerfield, Q. (1983). Audio-visual Speech Perception, Lip Reading and Ratificial Stimulation. In M.P.Haggard & M.E.Lutman (Eds.). Hearing Science and Hearing Disorders. London: Academic Press.

Chandrashekara, S.K.. (1972). Development and Standardization of Speech Test Material in English for Indians. Unpublished Masteral Dissertation, University of Mysore, India.

Tillman, T.W. & Carhart, R (1963). A Text for Speech Discrimination Composed of CNC Monosyllabic Words. In Rintelmann, W. (1979) (Ed.). Hearing Assessment Boston : Allyn and Bacon.

Tillman, T.W., Carhart, R. & Wilber, L. (1963). Cited in Kruger, B. & Mazor, R.M. Speech Audiometry in U.S.A. In M.Martin (Ed.). Speech Audiometry. London : Whurr Publishers Ltd.

Tillman, T.W. & Carhart, R (1966). Cited in Dillon, S.J. & Ching, T. (1995). What Makes a Good Speech Test? InG.Plant&KJE.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr Publishers Ltd.

Tobias, J. V. (1964). On Phonemic Analysis of Speech Discrimination Tests. Journal of Speech and Hearing Research, 7, 98-100.

Tyler, R., Preece, J. & Lowder, M (1983). Cited in Dillon, S.J. & Ching, T. (1995). What Makes a Good Speech Test? In G.Plant & K.E.Spens (Eds.). Profound Deafness and Speech Communication. London : Whurr Publishers Ltd.

Urbart-schitsch, V. (1895). Auditory Training for Deaf Mutism and For Deafness Acquired in Later Life. Vienna : Urban and Schwarzenberg. In Martin, M. (1987). Speech Audiometry. London : Whurr Publishers Ltd.

Vandana, S. (1998). Speech Identification Test for Kannada Speaking Children. Unpublished Independent Project. University of Mysore, Mysore.

Ventry, I.M. (1976). Puretone Spondee Threshold Relationships in Functional Hearing Loss. Journal of Speech and Hearing Disorders, 41, 16-22.

Walden, B.E., Montgomery, A.A., Prose, K.R.A. & Hawkins, D.B. (1990). Visual Biasing of Normal and Impaired Auditory Speech Perception. Journal of Speech and Hearing Research, 33, 163-73.

Wang, M.D. & Bilger, R.C. (1973). Consonant Confusions in Noise : A Study of Perceptual Features. Journal of Acoustical Society of America, 54, 1248-66.

Wittich, W., Wood, T.J. & Mahaffey, R.B. (1971). Computerized Speech Audiometry. Journal of Auditory Research, 11, 335-44.

Wolf, O. (1874).cited J.J. O'Neil and H.J. Oyer (1966). Applied Audiometry. Toronto : New York : Dodd Mead Company Inc.

APPENDIX

APPENDIX - I

FAMILIARIZATION ITEMS:

1. (1) /a:mai/ ஆமை
2. (2) /vandi/ வண்டி
3. (4) /a:ni/ ஆணி

LIST 'A':

01) (3) /kattii/ கட்டில்

02) (4) /ca:vi/ சாவி

03) (4) **/ṭattu/** தட்டு

04) (2) /ka:kka/ காக்கா

05) (1) /mayil/ மயில்

06) (3) /mi:sai/ மீசை

07) (2) /kaikal/ கைகள்

08) (3) /cattai/ சட்டை

09) (3) /mi:nkal/ மீன்கள்

10) (1) /ro:ja/ ரோஜா

11) (2) /roamga/ மாங்கா

12) (4) /erumbu/ எறும்பு

13) (1) /mu:kku/ மூக்கு

14) (2) /o:dam/ ஓடம்

15) (4) /si:ppu/ சீப்பு

16) (2) /ma:du/ மாடு

17) (2) /puli/ புலி

18) (4) **/pandu/** பந்து

19) (3) **/da:di/** தாடி

20) (2) /pa:nai/ பானை

21) (4) /palli/ பல்லி

22) (3) /maram/ மரம்

23) (4) /eli/ எலி

24) (2) /ma:lai/ மாலை

25) (2) /jannal/ ஜன்னல்

26) (1) **/katti/** கத்தி

27) (4) /laittu/ லைட்டு

28) (1) /pe:na/ பேனா

29) (2) /muyal/ முயல்

30) (2) /pu:nai/ பூனை

31) (3) /puikkal/ பூக்கள்

32) (1) /kudai/ குடை

33) (1) /ụ:njal/ ஊஞ்சல்

34) (3) /ra:ja/ ராஜா

35) (4) /nila/ நிலா

36) (3) /pa:mbu/ பாம்பு

37) (4) /na:kku/ நாக்கு

38) (2) /nagam/ நகம்

39) (2) **/va:ṭṭu/** வாத்து

40) (1) /appa/ அப்பா

41) (3) /a:du/ ஆடு

42) (1) /e:ni/ ஏணி

43) (4) /vi:du/ வீடு

44) (1) /cedi/ செடி

45) (2) /ya:nai/ யானை

46) (3) /va:li/ வாலி

47) (1) /palam/ பழம்

48) (3) 7ko:li/ கோழி

49) (4) /ilay/ இலை

50) (3). /amma/ அம்மா.

List A is reverse order of list A

33) (4) /mi:nkaL/ மீன்கள்

34) (2) /TOX ja/ ரோஜா

35) (3) /ma:nga/ மாங்கா

36) (2) /erumbu/ எறும்பு

37) (2) /mu:kku/ மூக்கு

38) (4) /o:dara/ ஓடம்

39) (3) /si:ppu/ சீப்பு

40) (2) /amma/ அம்மா

41) (1) /ma:du/ மாடு

42) (4) /puli/ புலி

43) (2) **/pandu/** பந்து

44) (4) **/da:di/** தாடி

45) (3) /pa:nai/ பானை

46) (2) /palli/ பல்லி

47) (4) /maram/ மரம்

48) (4) /eli/ எலி

49) (1) /ma:lai/ மாலை

50) (4) /appa/ அப்பா

List B[1] is reverse order of list B

APPENDIX - II

SCORE SHEET

NAME :

AGE / SEX :

SUBJECT / CASE NUMBER :

AUDIOLOGIC FINDINGS

	250 Hz,	500 Hz,	1000Hz,	2000Hz,	4000Hz,	8000Hz
AC Rt :						
AC Lt :						
BC :						

FALCONER'S AVERAGE ;

SIGNIFICANT HISTORY (IF ANY) :

SCORE KEY :

	MARKING	SCORE
CORRECT RESPONSE :	✓	2
INCORRECT RESPONSE :	✗	0

LIST A				LIST B			
01)	(3)	/kattil/	கட்டில்	01)	(1)	/jannal/	ஜன்னல்
02)	(4)	/ca:vi/	சாவி	02)	(3)	/kaṭṭi/	கத்தி
03)	(4)	/ṭattu/	தட்டு	03)	(3)	/laittu/	லைட்டு
04)	(2)	/ka:kka/	காக்கா	04)	(1)	/pe:na/	பேனா
05)	(1)	/mayil/	மயில்	05)	(3)	/muyal/	முயல்
06)	(3)	/mi:sai/	மீசை	06)	(1)	/pu:nai/	பூனை

LIST A

07)	(2)	/kaikal/	கைகள்
08)	(3)	/oattai/	சட்டை
09)	(3)	/mi:nkal/	மீன்கள்
10)	(1)	/ro:ja/	ரோஜா
11)	(2)	/ma:nga/	மாங்கா
12)	(4)	/erurabu/	எறும்பு
13)	(1)	/mu:kku/	மூக்கு
14)	(2)	/o:dam/	ஓடம்
15)	(4)	/ai:ppu/	சீப்பு
16)	(2)	/ma:du/	மாடு
17)	(2)	/puli/	புலி
18)	(4)	**/panḍu/**	பந்து
19)	(3)	**/ḍa:di/**	தாடி
20)	(2)	/pa:nai/	பானை
21)	(4)	/palli/	பல்லி
22)	(3)	/marara/	மரம்
23)	(4)	/eli/	எலி
24)	(2)	/ma:lai/	மாலை

LIST B

07)	**(4)**	**/pu:kkal,/**	பூக்கள்
08)	**(2)**	**/kudai/**	குடை
09)	**(2)**	**/u:njal/**	ஊஞ்சல்
10)	**(2)**	**/ra:ja/**	ராஜா
11)	**(1)**	**/nila/**	நிலா
12)	**(1)**	**/pa:mtou/**	பாம்பு
13)	**(3)**	**/na:kku/**	நாக்கு
14)	**(3)**	**/nagam/**	நகம்
15)	**(1)**	**/va:ttu/**	வாத்து
16)	**(4)**	**/a:du/**	ஆடு
17)	**(3)**	**/e:ni/**	ஏணி
18)	**(3)**	**/vi:du/**	வீடு
19)	**(1)**	**/cedi/**	செடி
20)	**(4)**	**/ya:nai/**	யானை
21)	**(1)**	**/va:li/**	வாளி
22)	**(2)**	**/palam/**	பழம்
23)	**(2)**	**/ko:li/**	கோழி
24)	**(3)**	**/ilay/**	இலை

LIST A				LIST B			
25)	(2)	/jannal/	ஜன்னல்	25)	(4)	/kattil/	கட்டில்
26)	(1)	**/katti/**	கத்தி	26)	(2)	/ca:vi/	சாவி
27)	(4)	/laittu/	லைட்டு	27)	(3)	/tattu/ n	தட்டு
28)	(1)	Vpe:na/	பேனா	28)	(2)	/ka:kka/	காக்கா
29)	(2)	/muyal/	முயல்	29)	(4)	/mayil/	மயில்
30)	(2)	/pu:nai/	பூனை	30)	(4)	/mi:sai/	மீசை
31)	(3)	/pu:kkal/	பூக்கள்	31)	(1)	/kaikftl/	கைகள்
32)	(1)	/kudai/	குடை	32)	(4)	/cattai/	சட்டை
33)	(1)	/u:njal/	ஊஞ்சல்	33)	(4)	/rai:nkal/	மீன்கள்
34)	(3)	/ra:ja/	ராஜா	34)	(2)	/ro:ja/	ரோஜா
35)	(4)	/nila/	நிலா	35)	(3)	/ma:nga/	மாங்கா
36)	(3)	/pa:mbu/	பாம்பு	36)	(2)	/erurabu/	எறும்பு
37)	(4)	/na:kku/	நாக்கு	37)	(2)	/mu:kku/	மூக்கு
38)	(2)	/nagam/	நகம்	38)	(4)	/o:dam/	ஓடம்
39)	(2)	**/va:ttu/**	வாத்து	39)	(3)	/si:ppu/	சீப்பு
40)	(1)	/appa/	அப்பா	40)	(2)	/amma/	அம்மா
41)	(3)	/a:du/	ஆடு	41)	(1)	/ma:du/	மாடு
42)	(1)	/e:ni/	ஏணி	42)	(4)	/puli/	புலி

LIST A				LIST B			
43)	(4)	/vi:du/	வீடு	**43)**	**(2)**	**/pandu/**	பந்து
44)	(1)	/cedi/	செடி	**44)**	**(4)**	**/da:di/**	தாடி
45)	(2)	/ya:nai/	யானை	**45)**	**(3)**	**/pa:nai/**	பானை
46)	(3)	/va:li/	வாலி	**46)**	**(2)**	**/palli/**	பல்லி
47)	(1)	/palam/	பழம்	**47)**	**(4)**	**/raaram/**	மரம்
48)	(3)	/ko:li/	கோழி	**48)**	**(4)**	**/eli/**	எலி
49)	(4)	/ilay/	இலை	**49)**	**(1)**	**/ma:lai/**	மாலை
50)	(3)	/arama/	அம்மா	**50)**	**(4)**	**/appa/**	அப்பா

List A[1] & B[1] are reverse orders of list A & B respectively.

	Presentation Level	Score
LIST A :		
LIST B :		
LIST A[1] :		
LIST B[1] :		
TOTAL SCORE :		

IMPRESSION : **SIGNATURE**

Appendix III

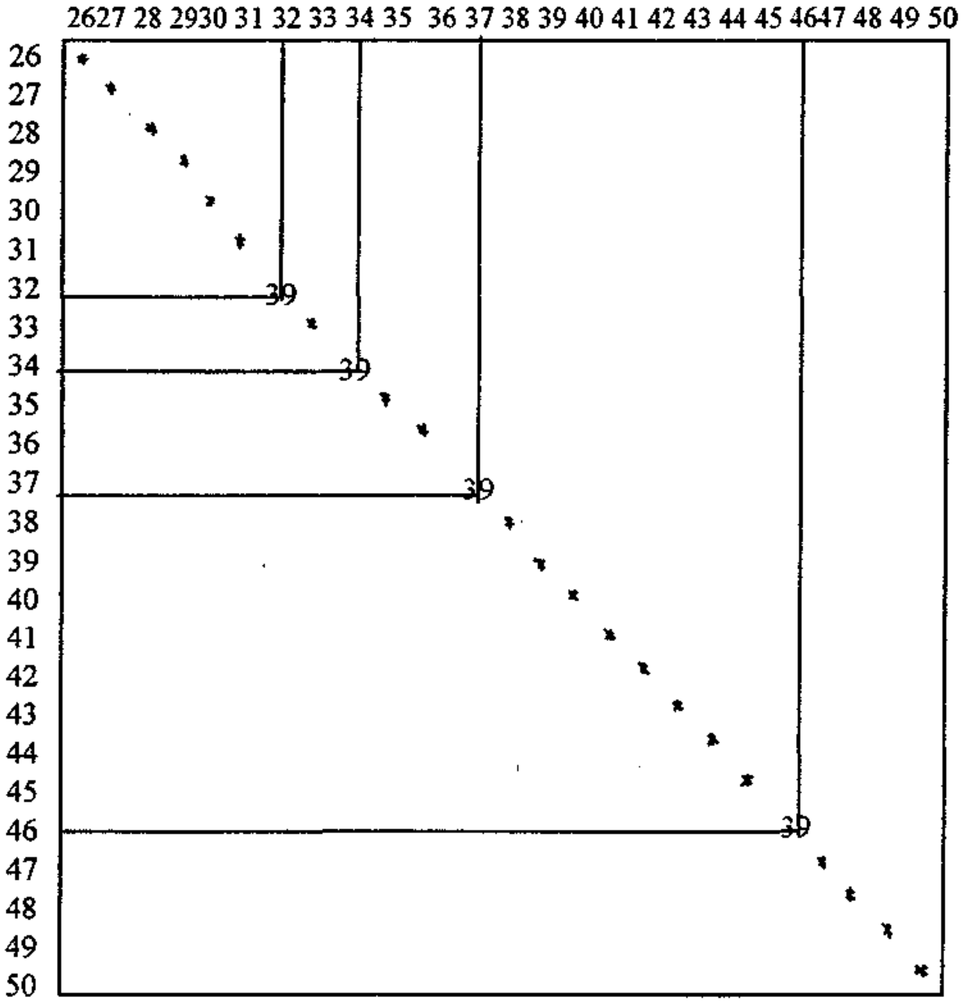
CONFUSION MATRIX [40dBSL]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	*																								
2		*																							
3			*																						
4				*																					
5					*																				
6						36																			
7							38																		
8								39																	
9									*																
10										*															
11											*														
12												*													
13													*												
14														*											
15															39										
16																*									
17																	*								
18																		*							
19																			*						
20																				39					
21																					*				
22																						39			
23																							*		
24																								*	
25																									*

* No error i.e. all 40 subjects responded correctly.

Appendix III

CONFUSION MATRIX (contd..)



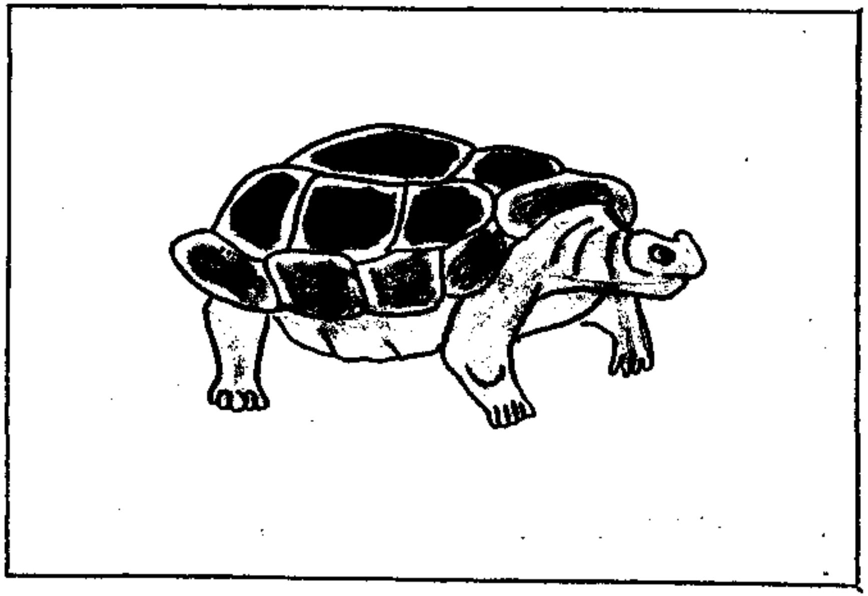
* No error i.e. all 40 subjects responded correctly..

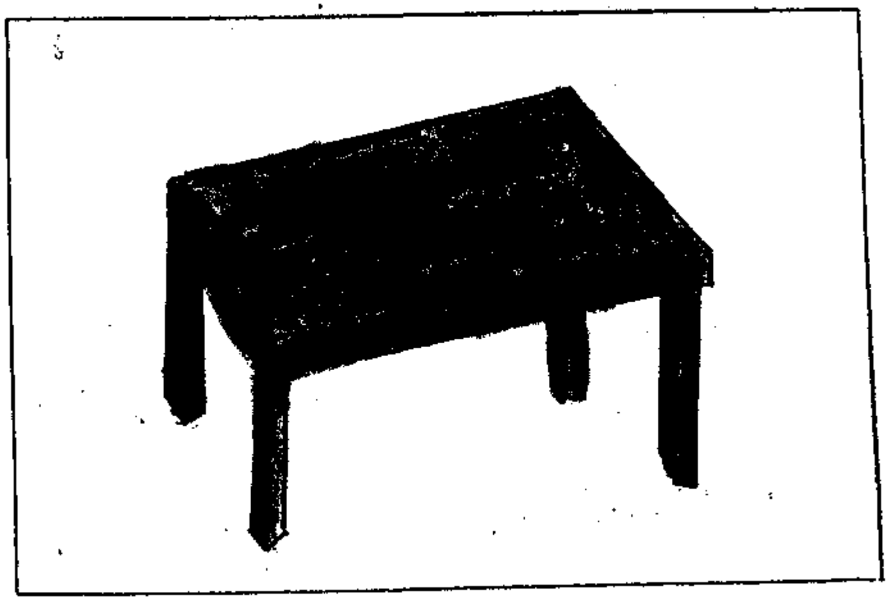
APPENDIX IV

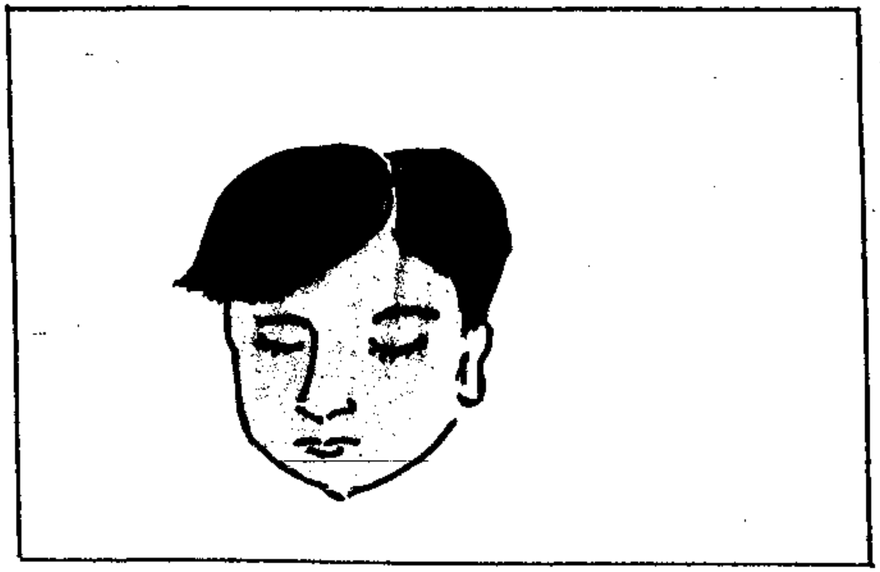
PICTURE BOOK

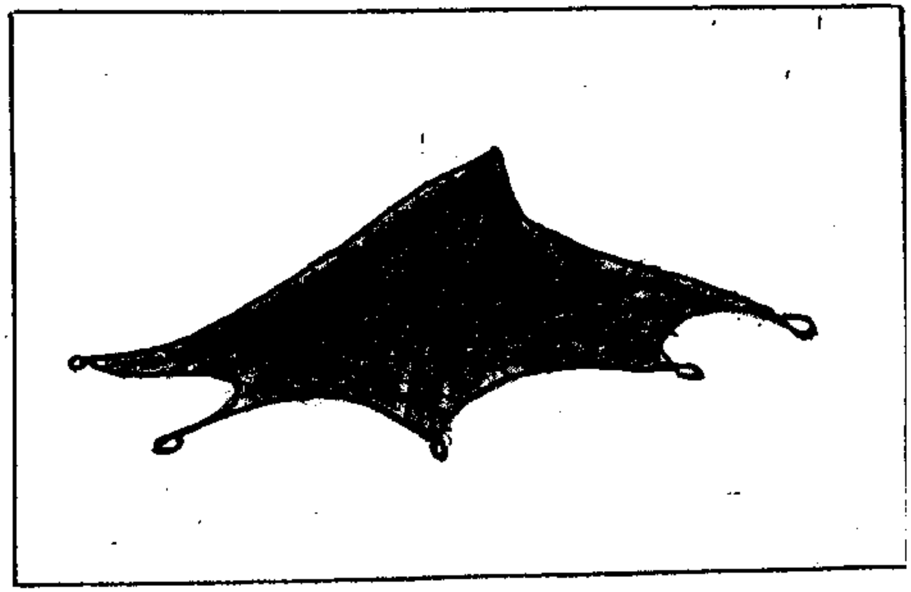
FAMILIARIZATION ITEMS

F1









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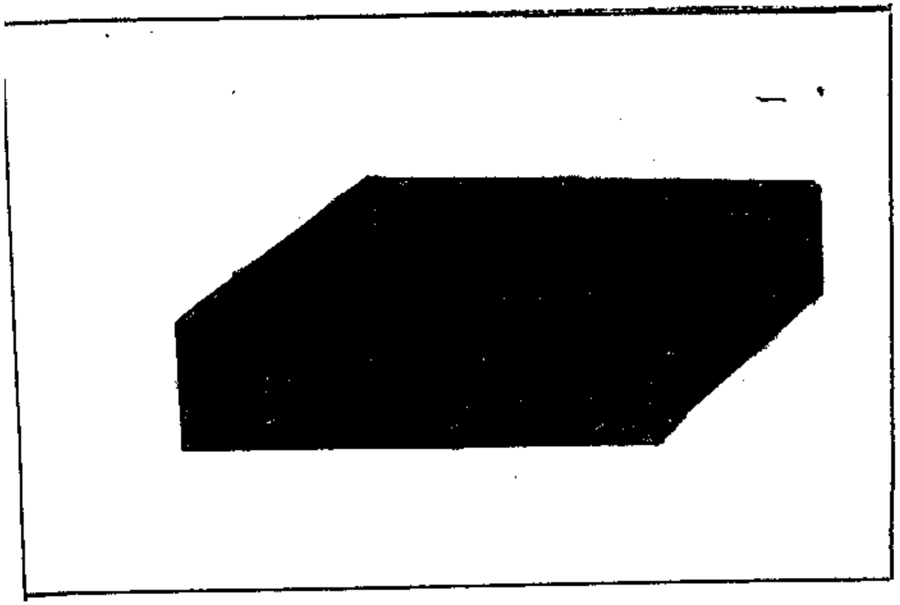
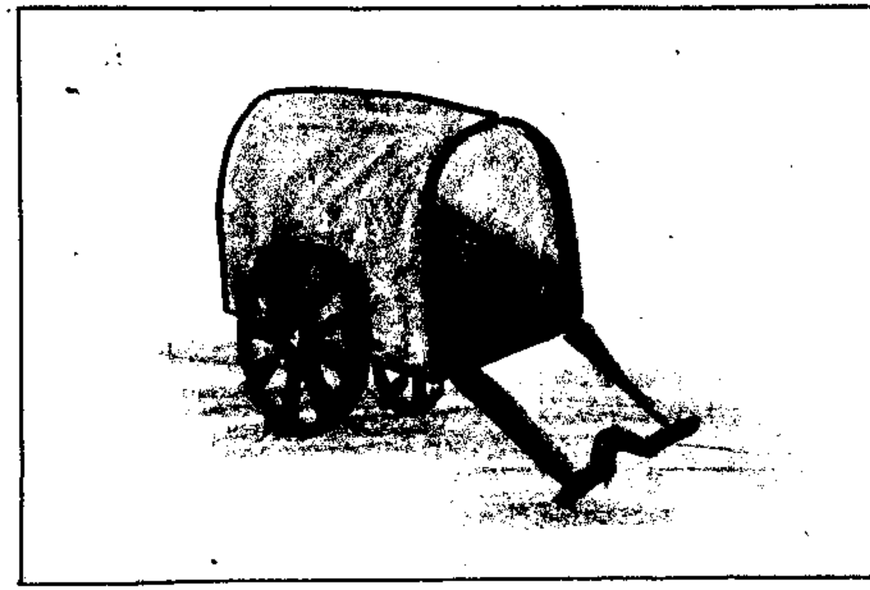
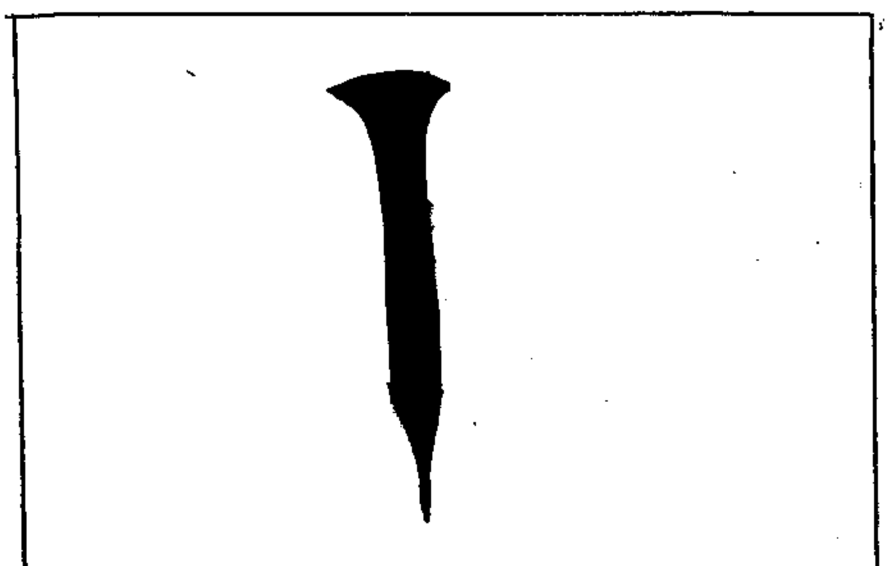
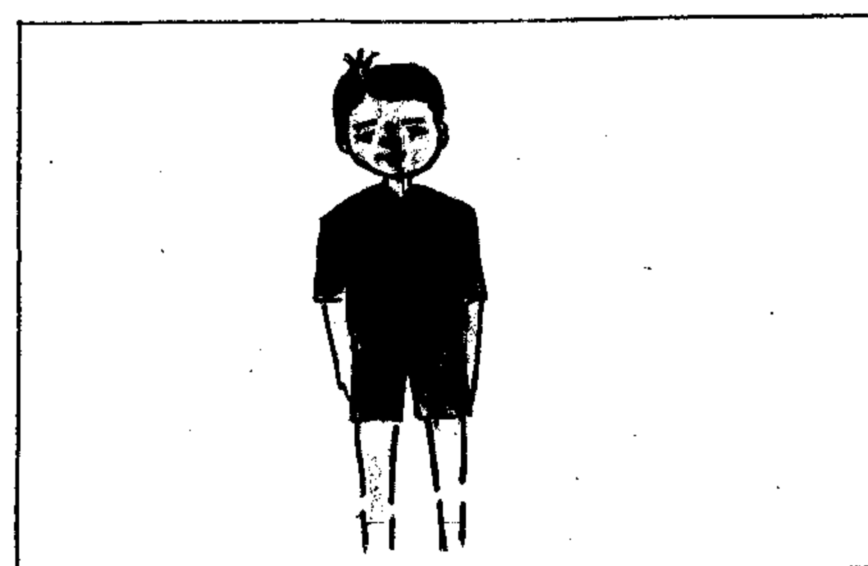
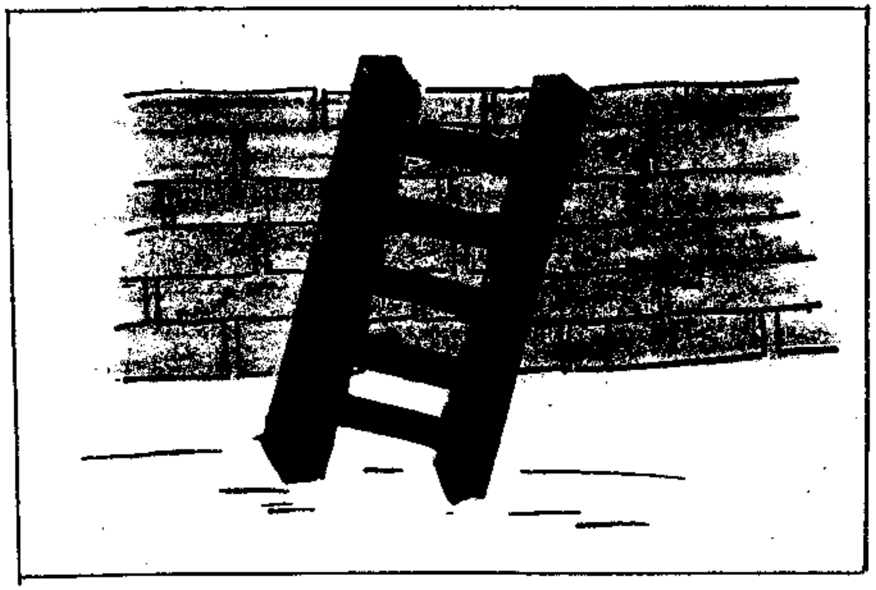


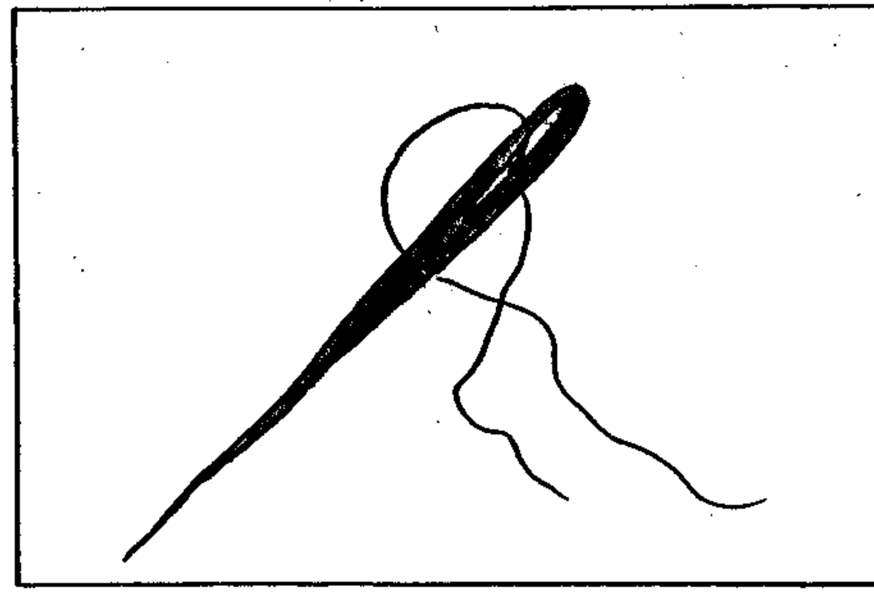


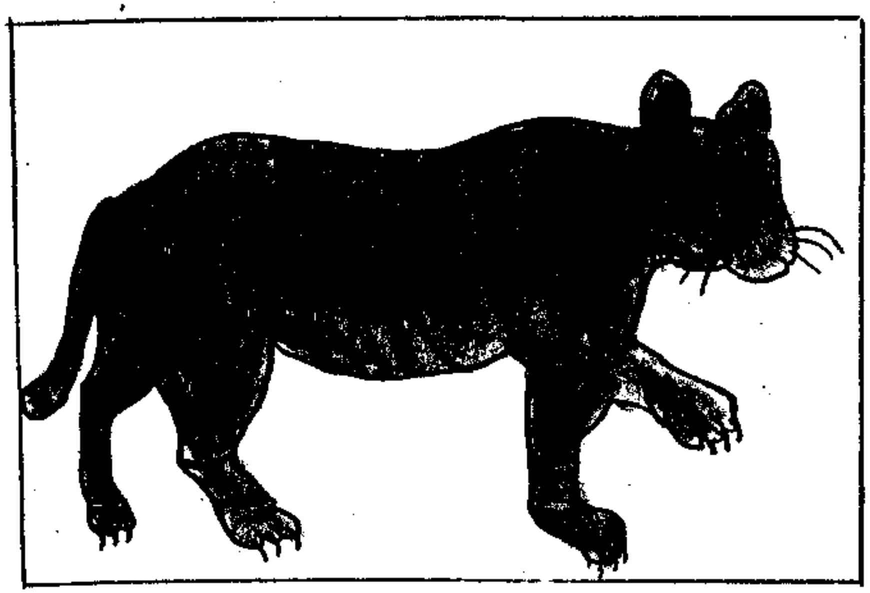


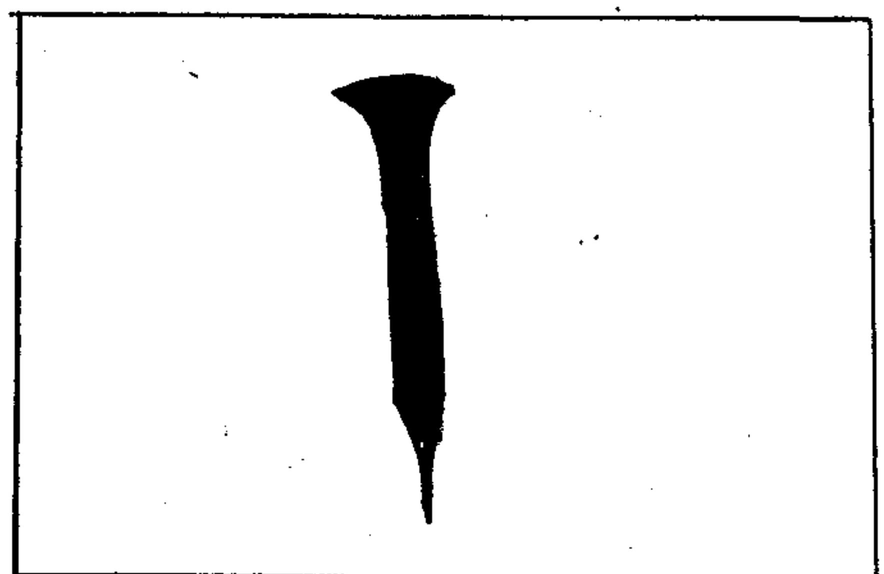


F3





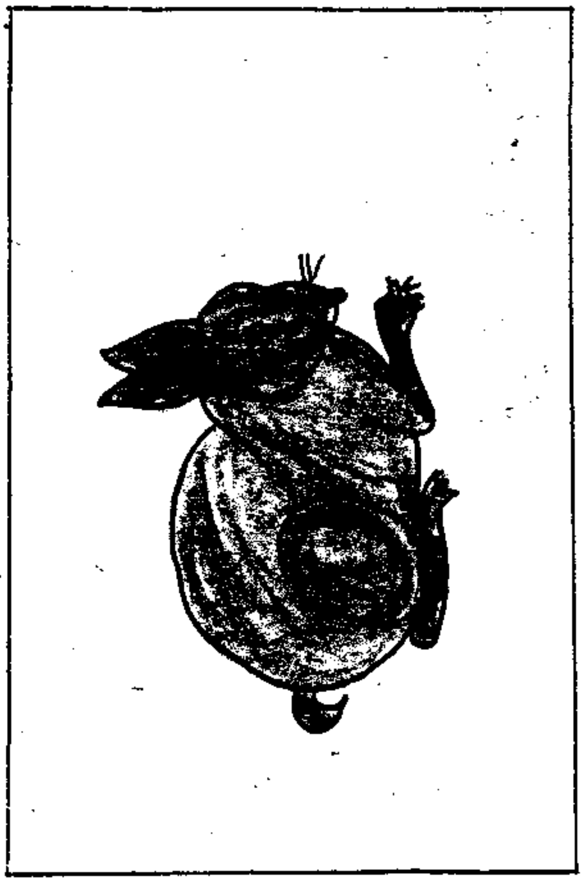


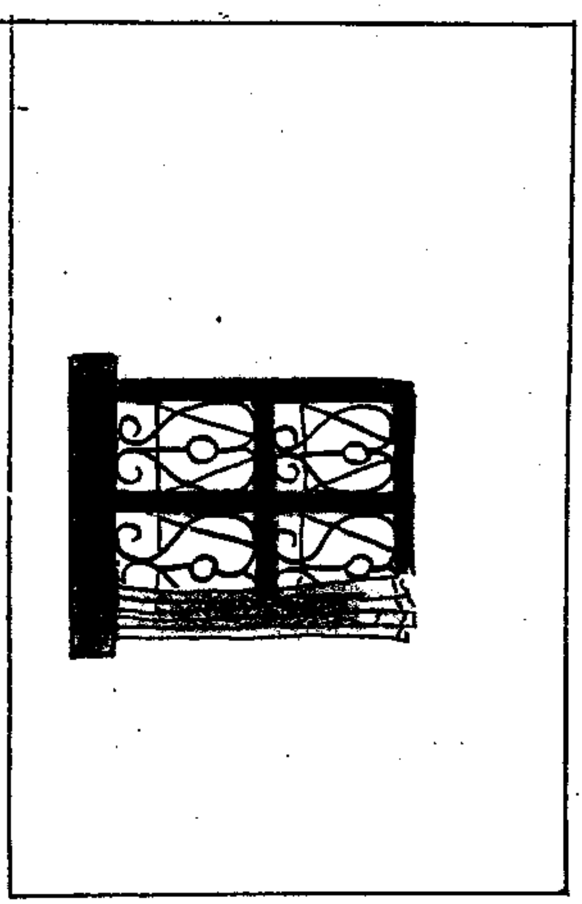


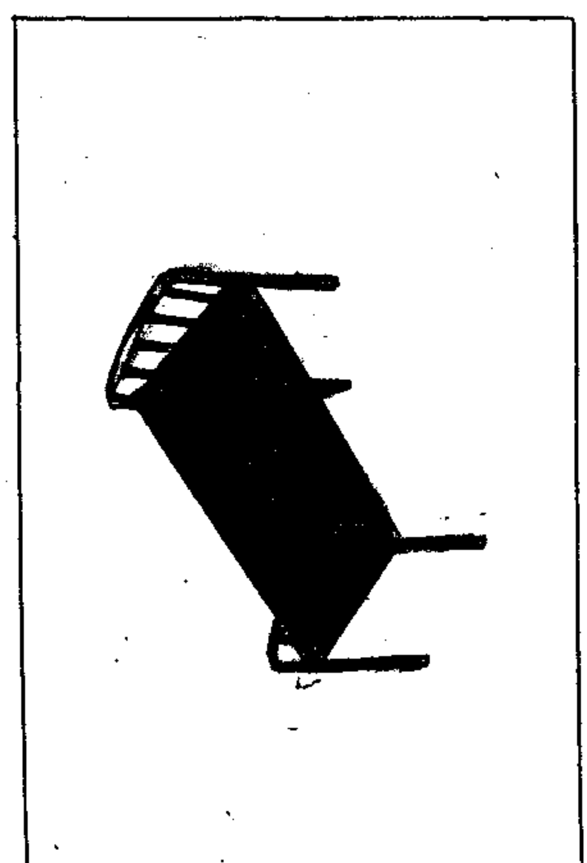
APPENDIX IV

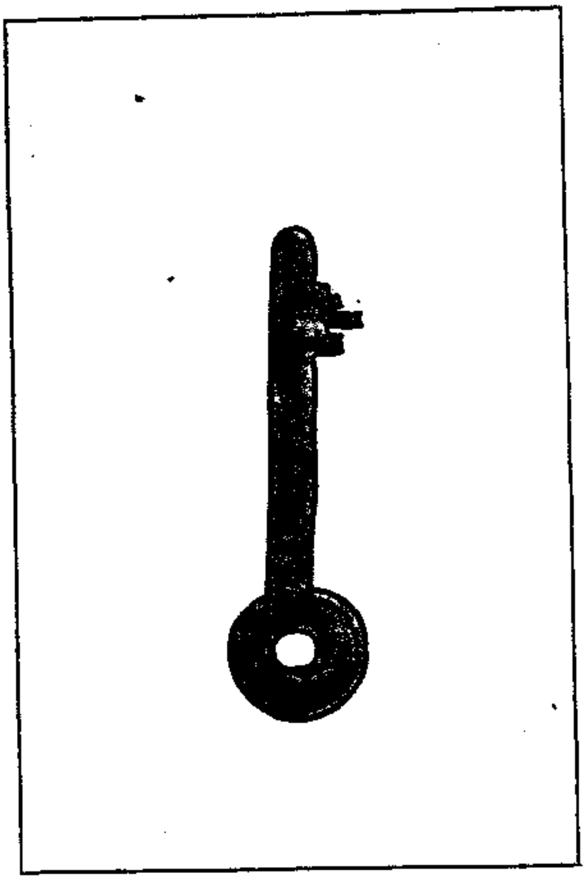
PICTURE BOOK

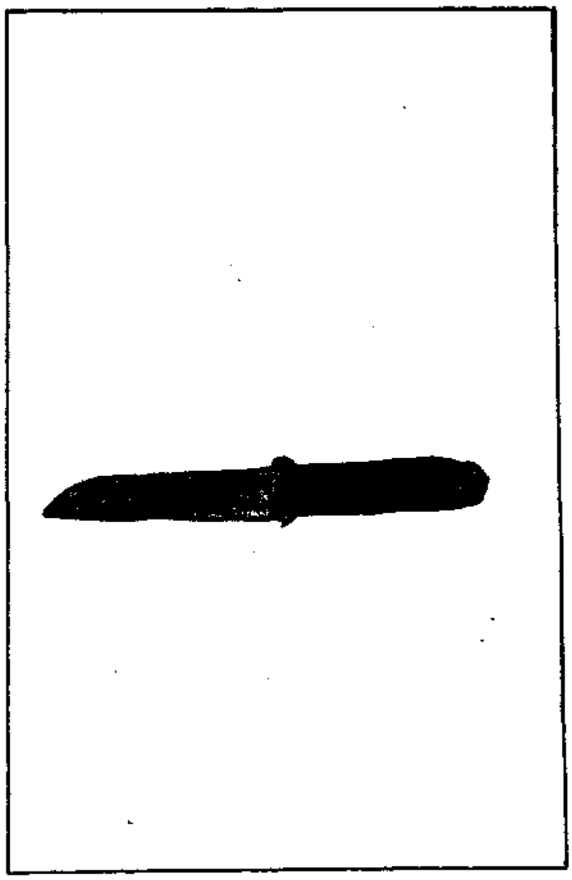
TEST ITEMS

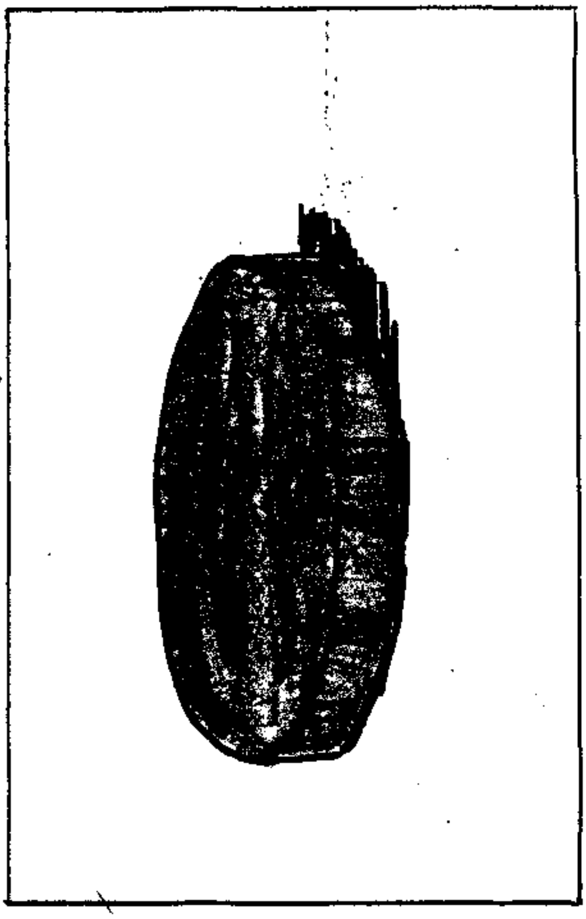


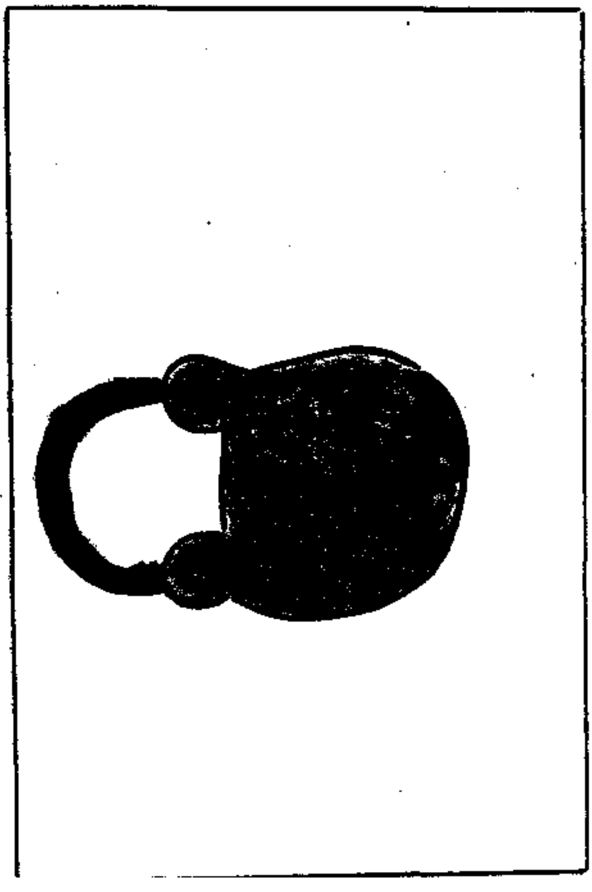


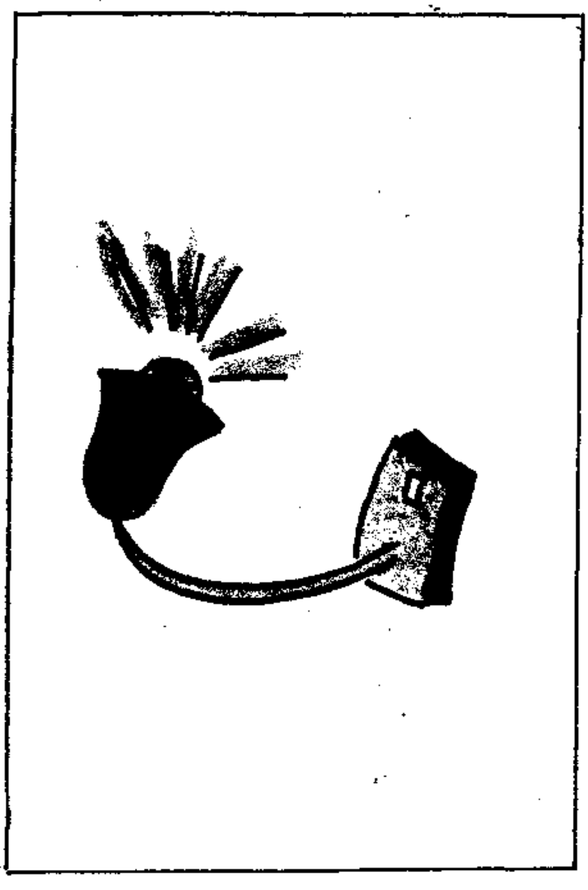


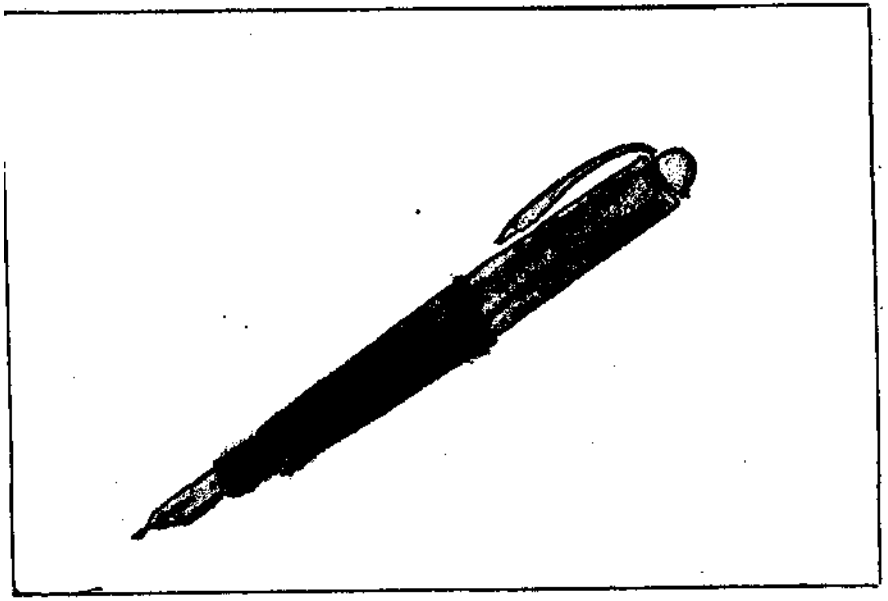


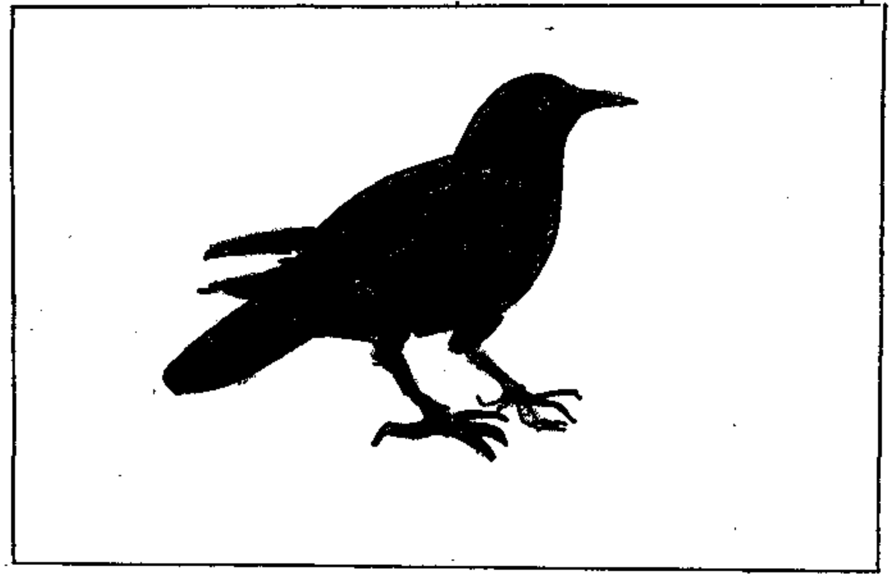


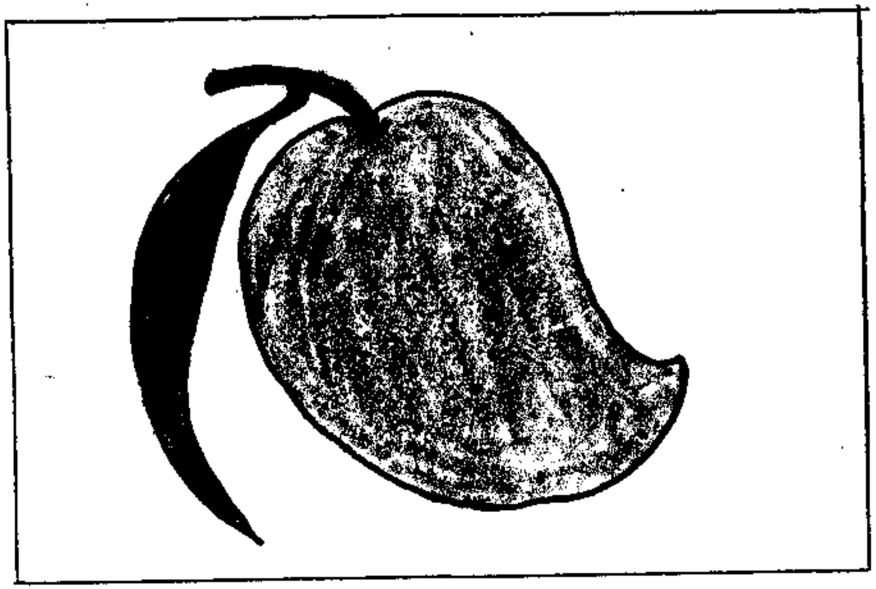


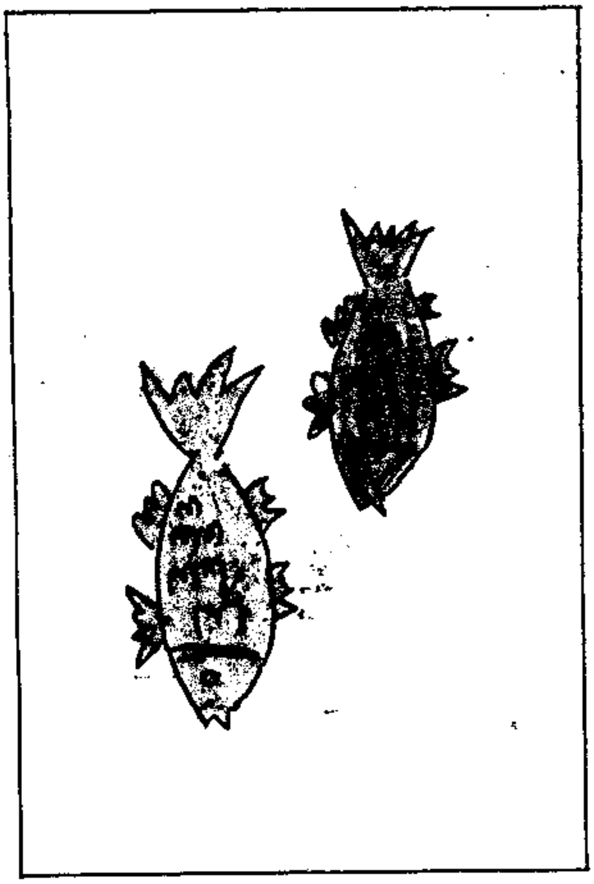


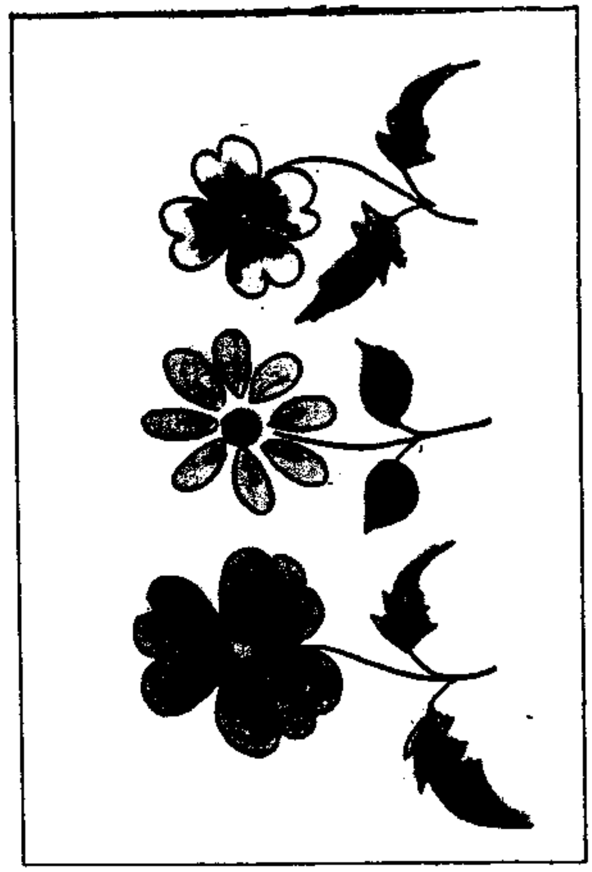


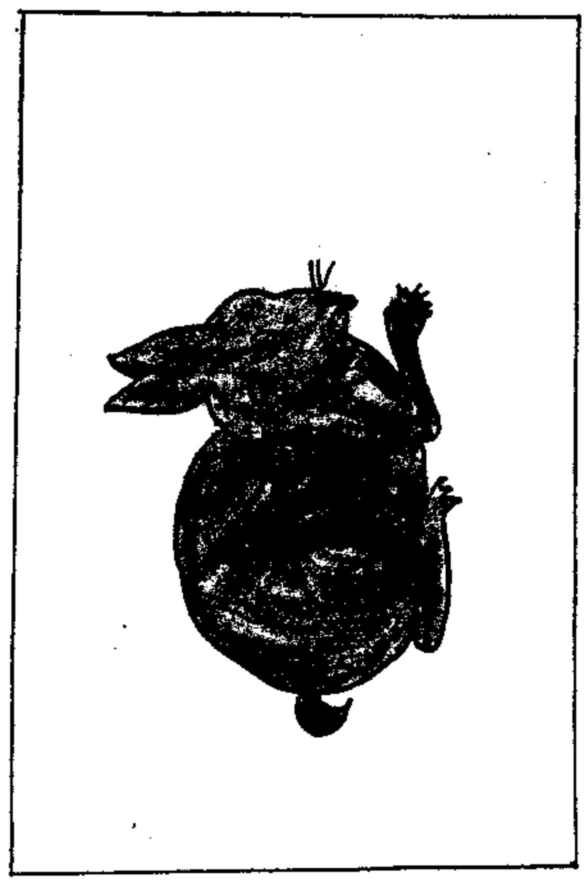


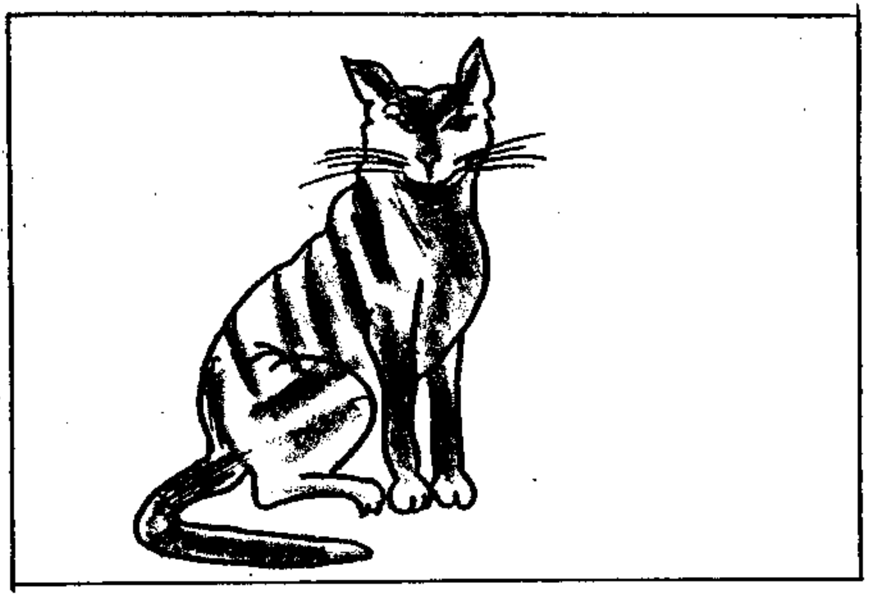


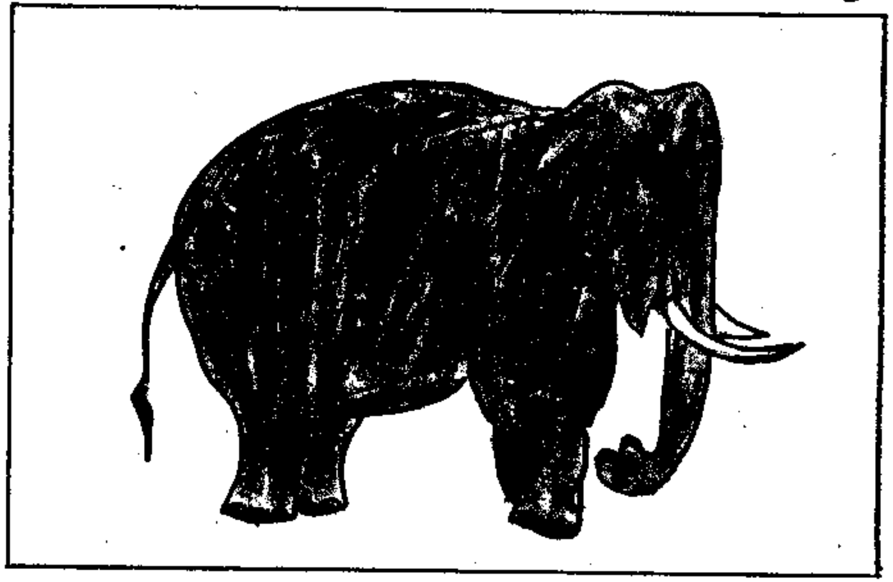


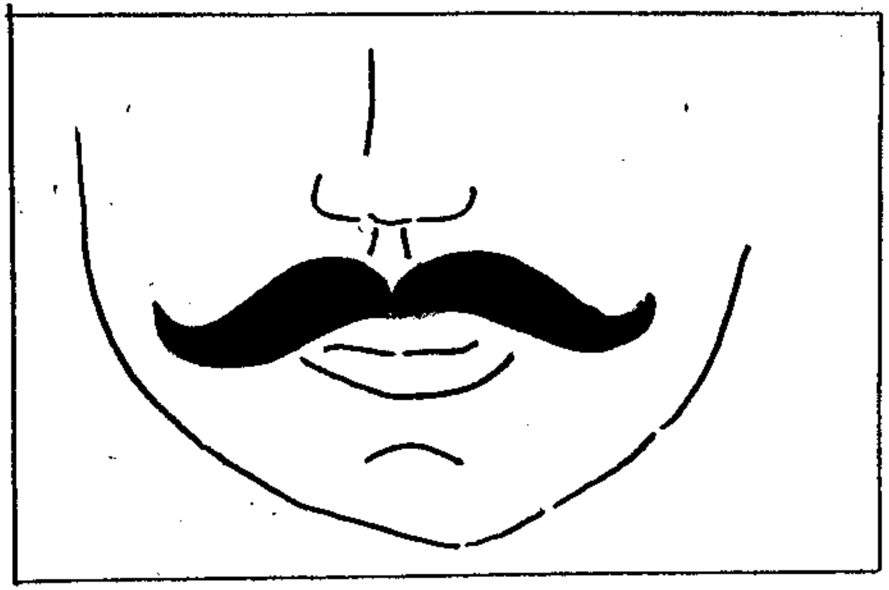


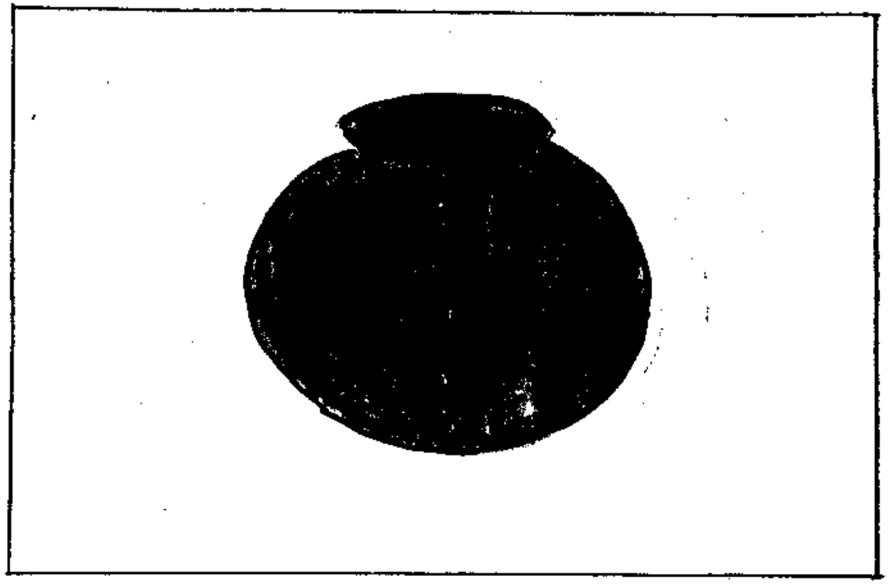


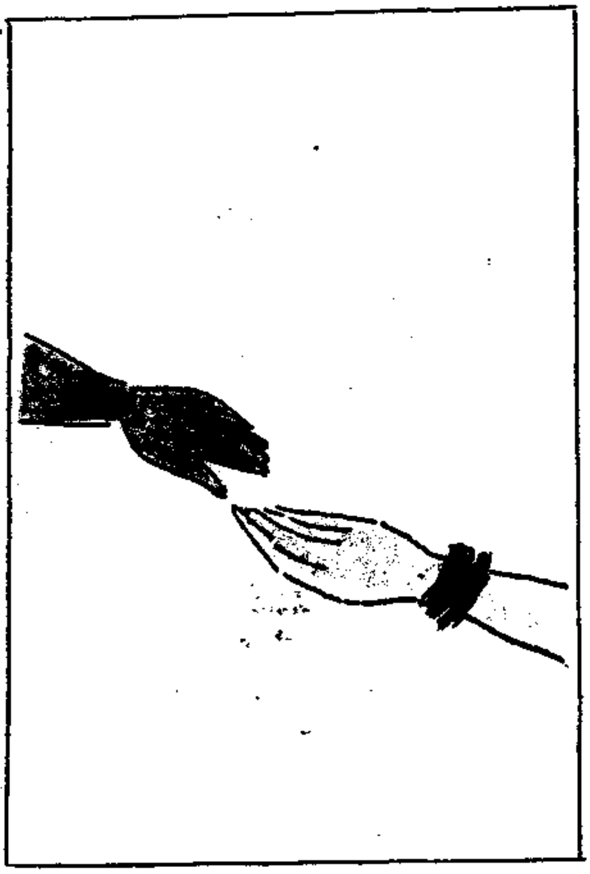


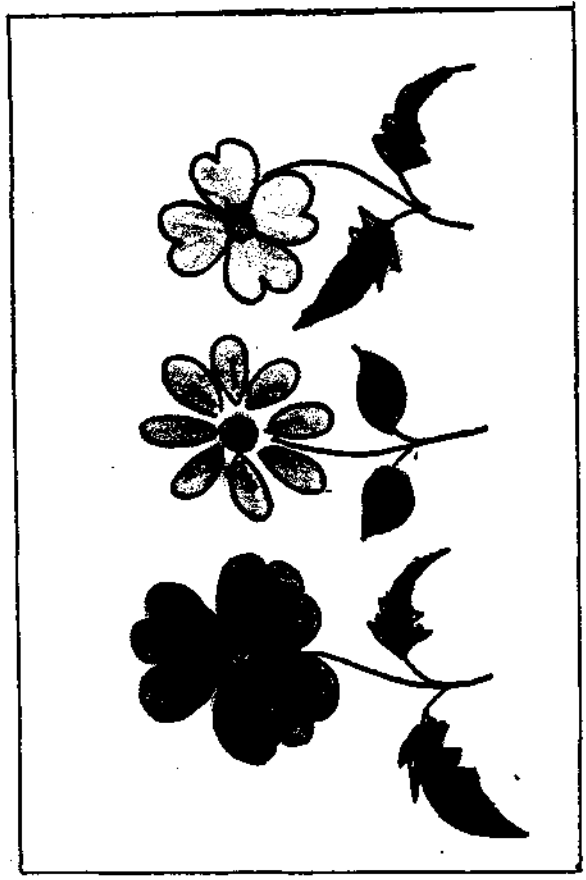


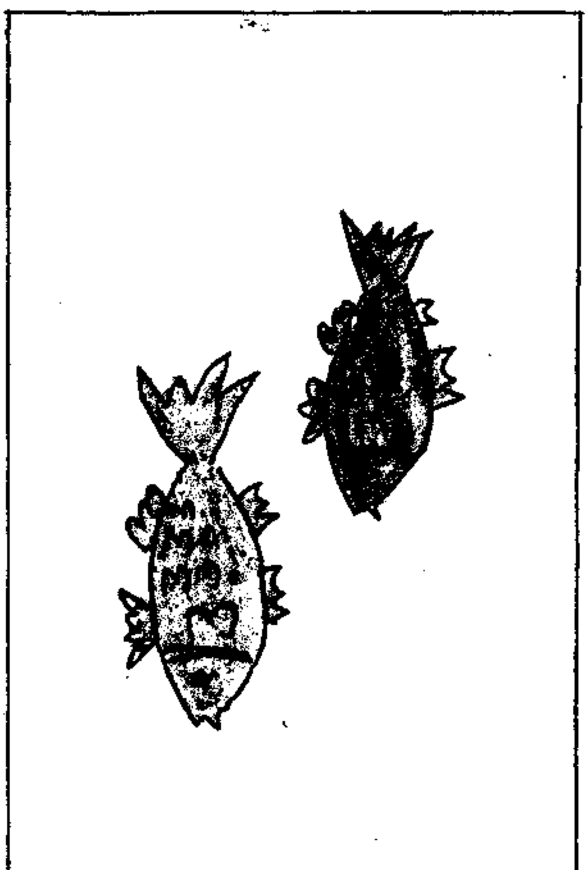


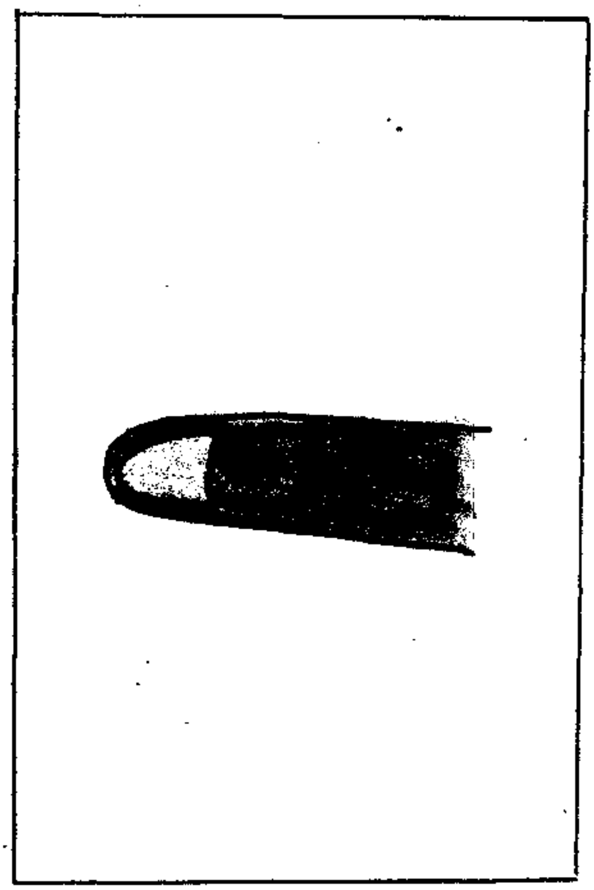












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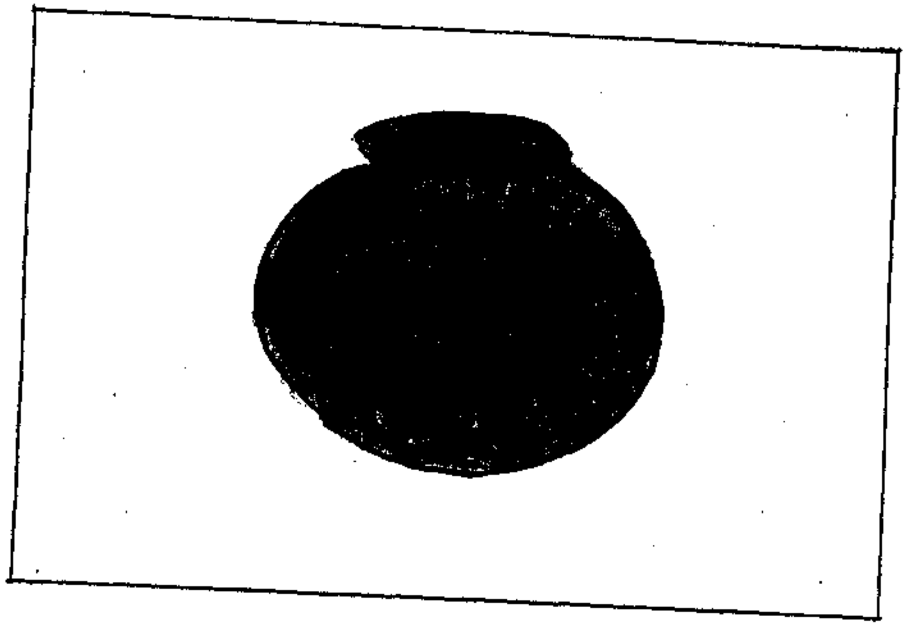

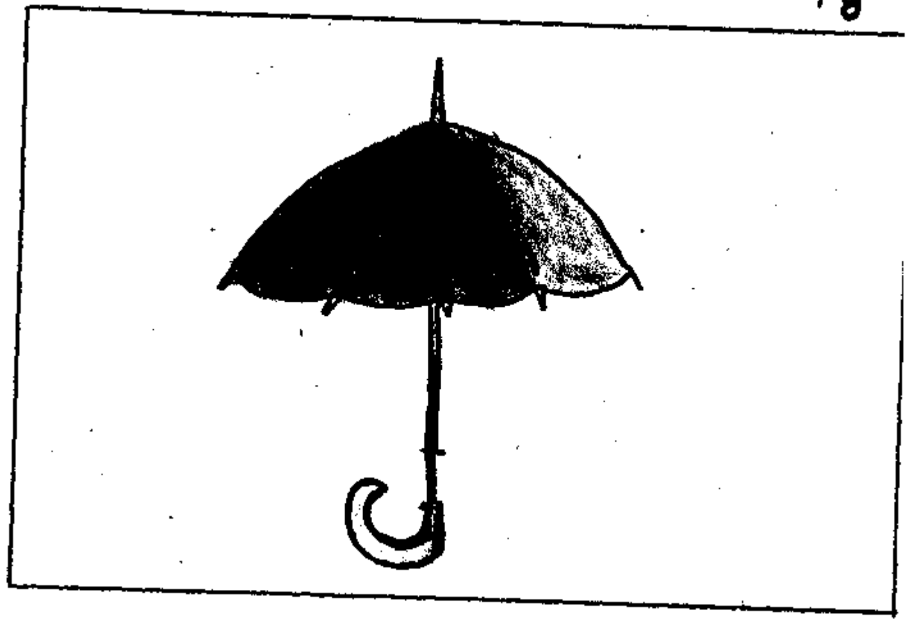

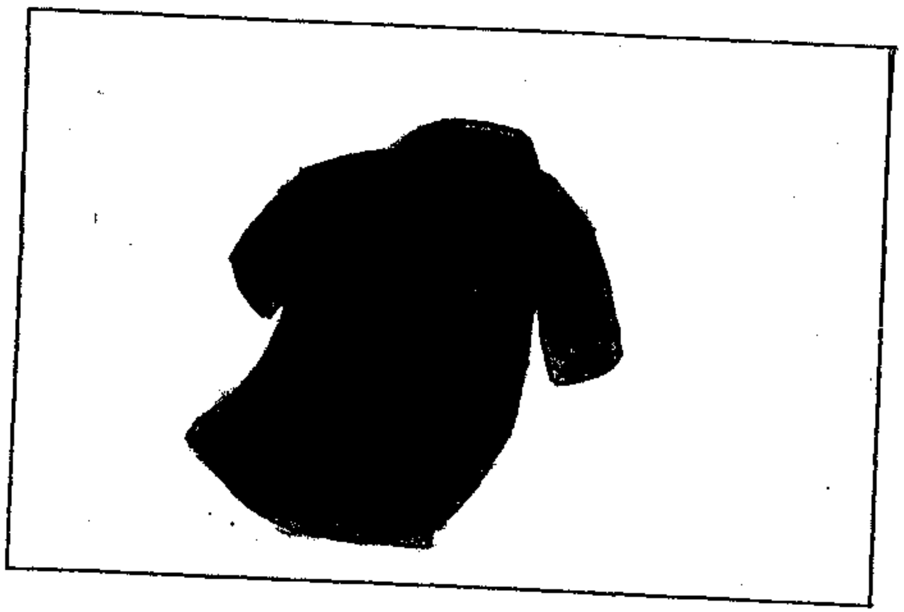

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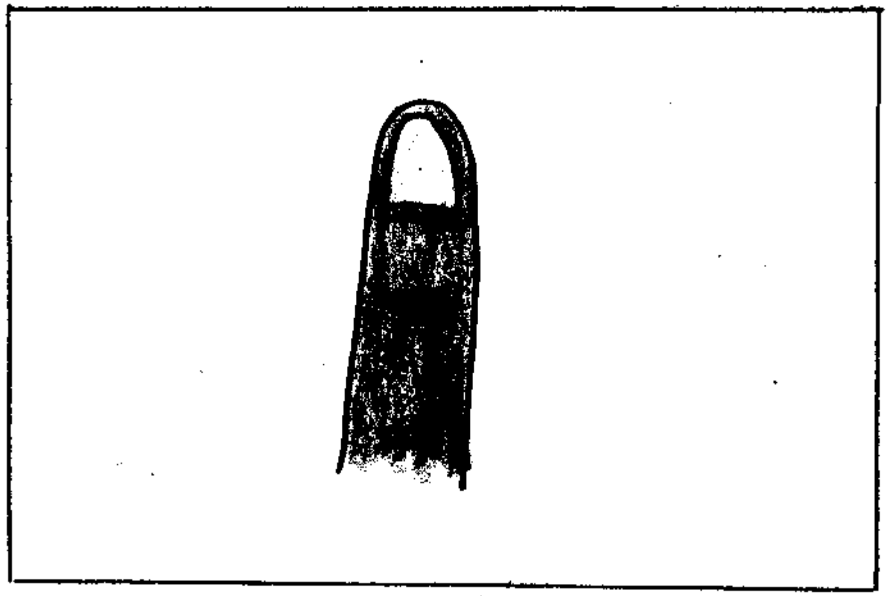
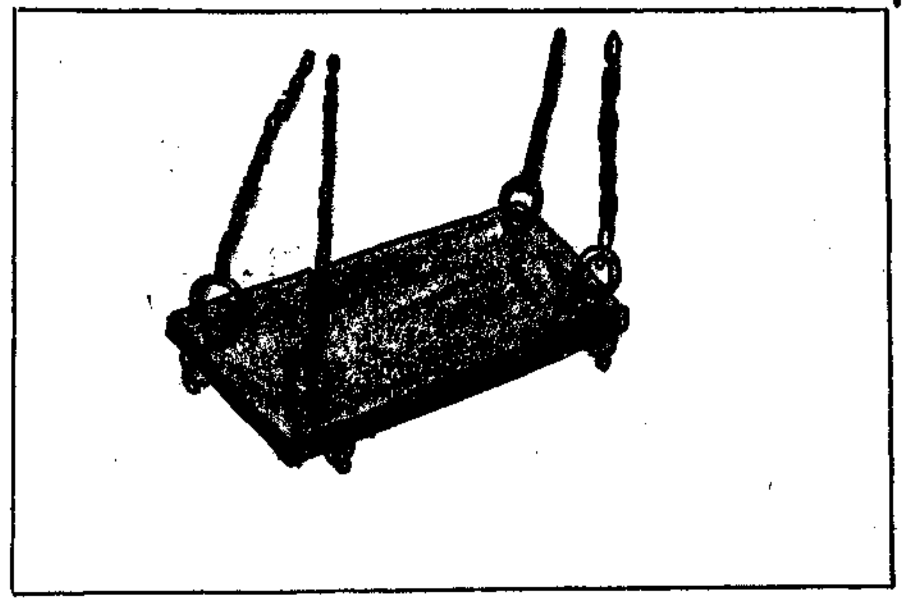
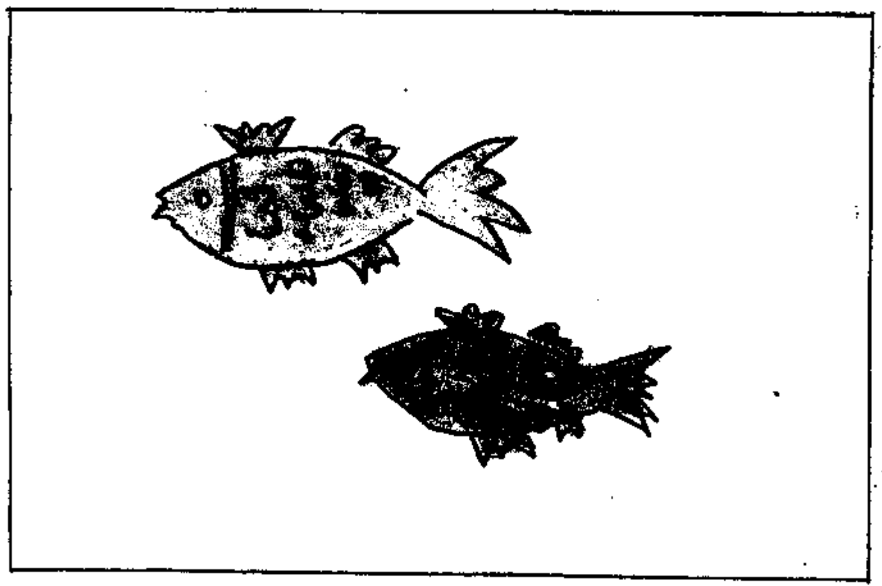
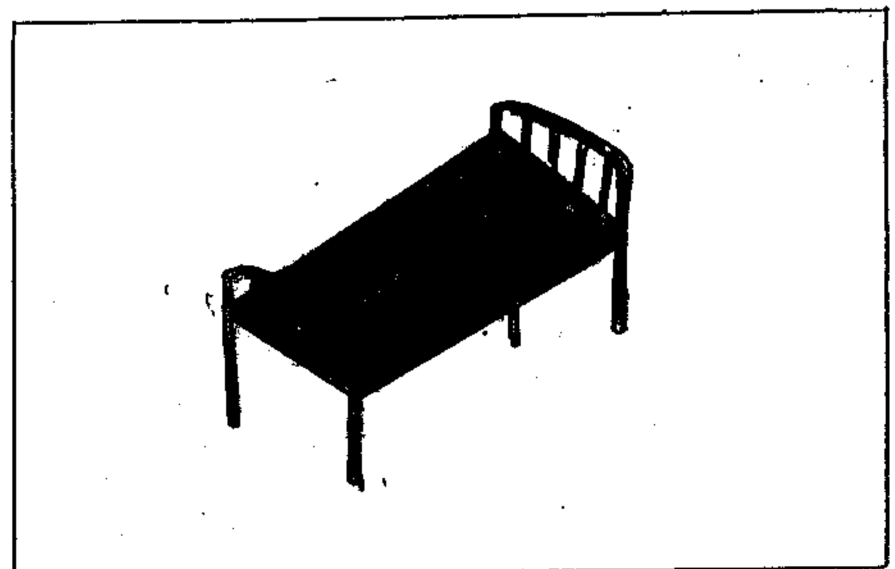
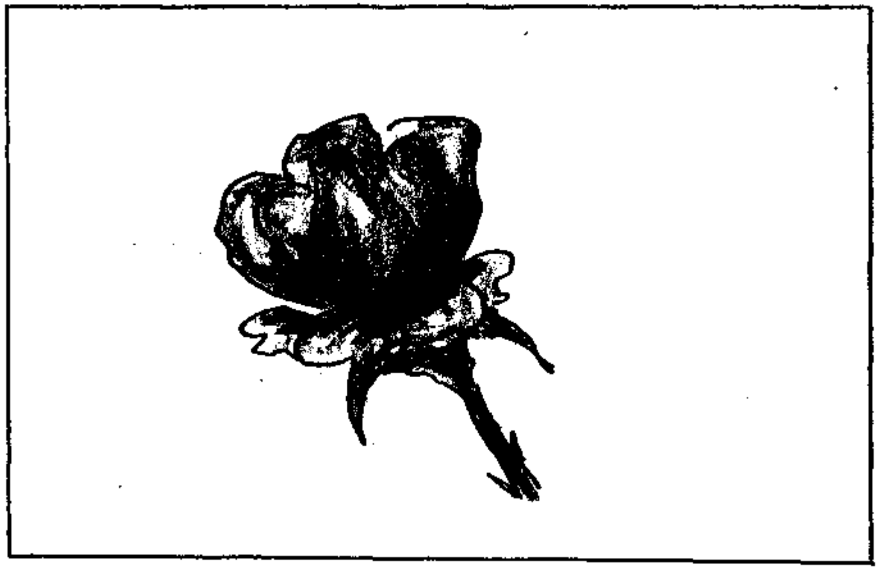


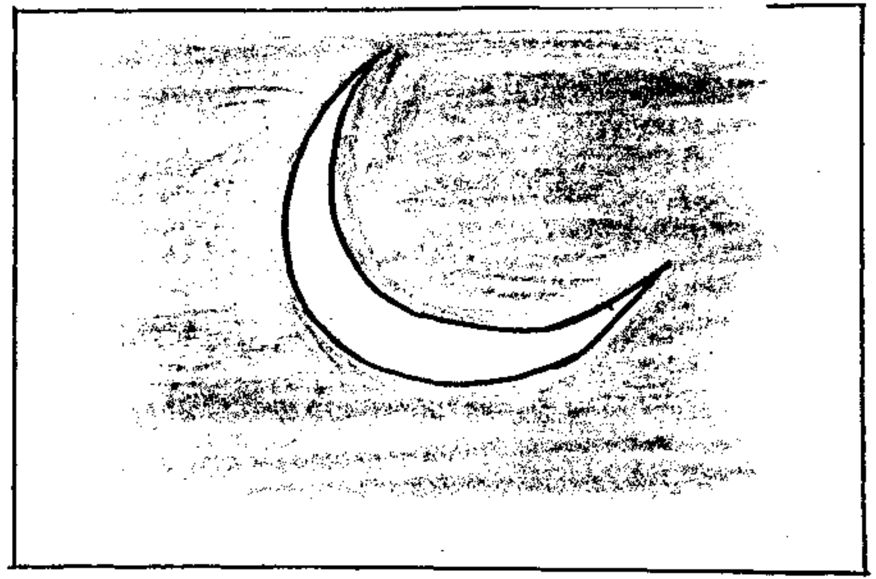






P10





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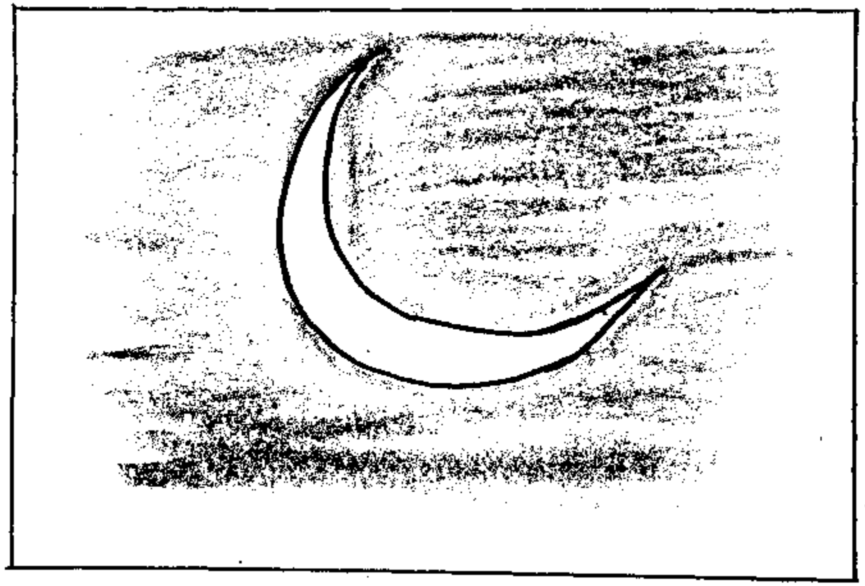

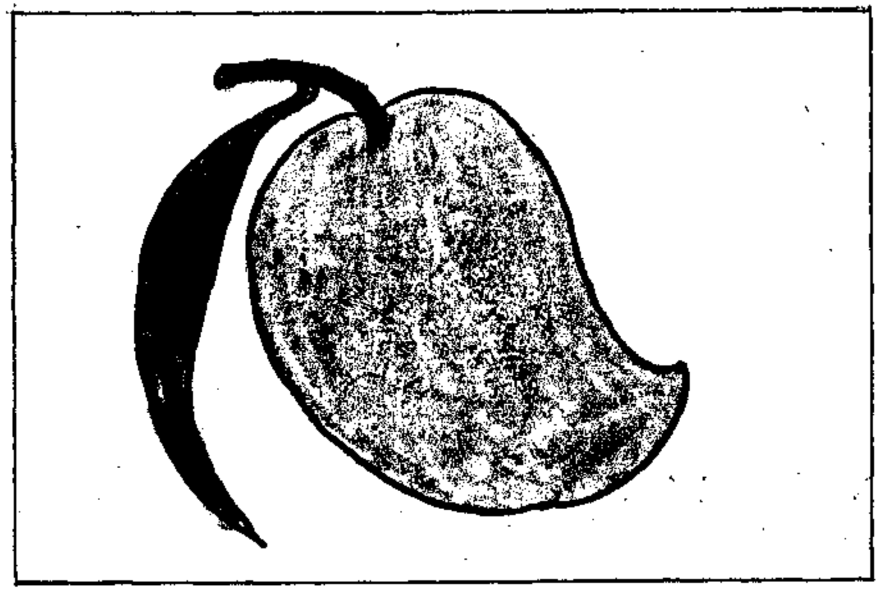

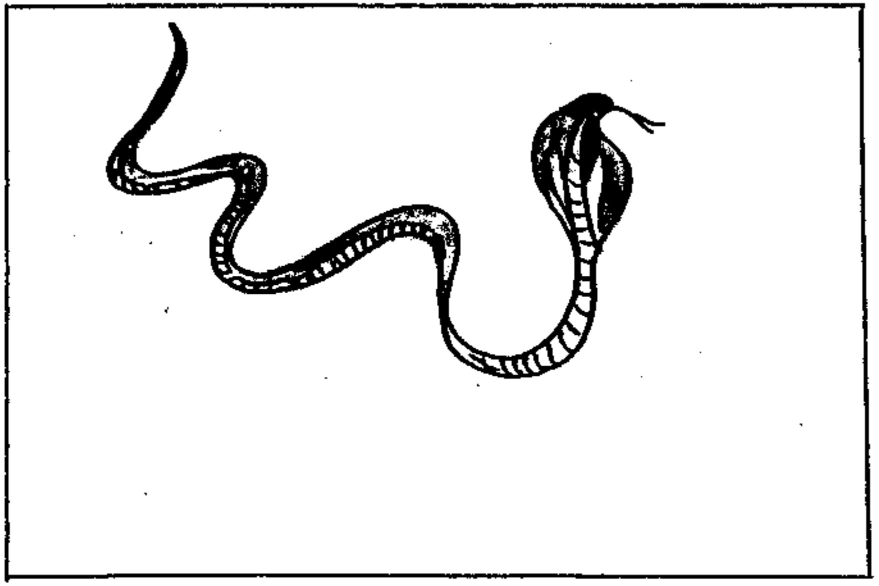

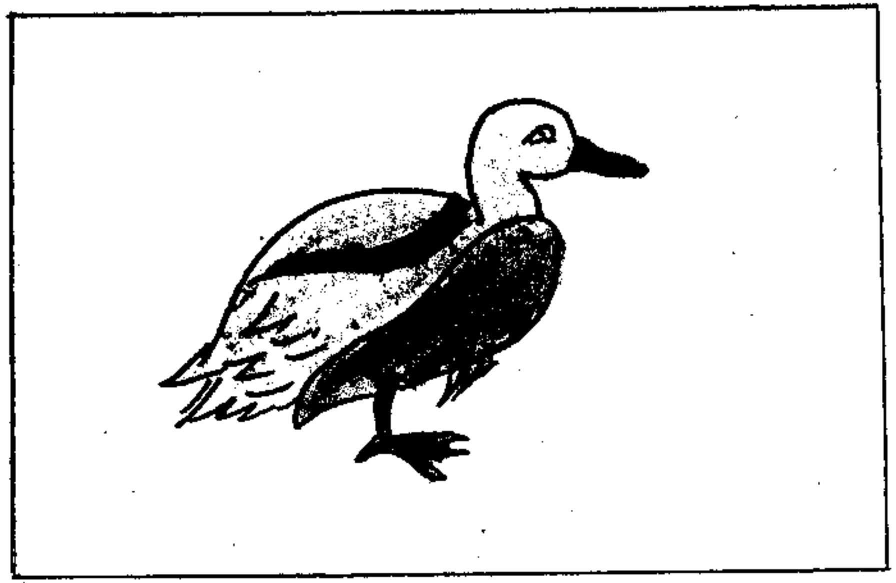

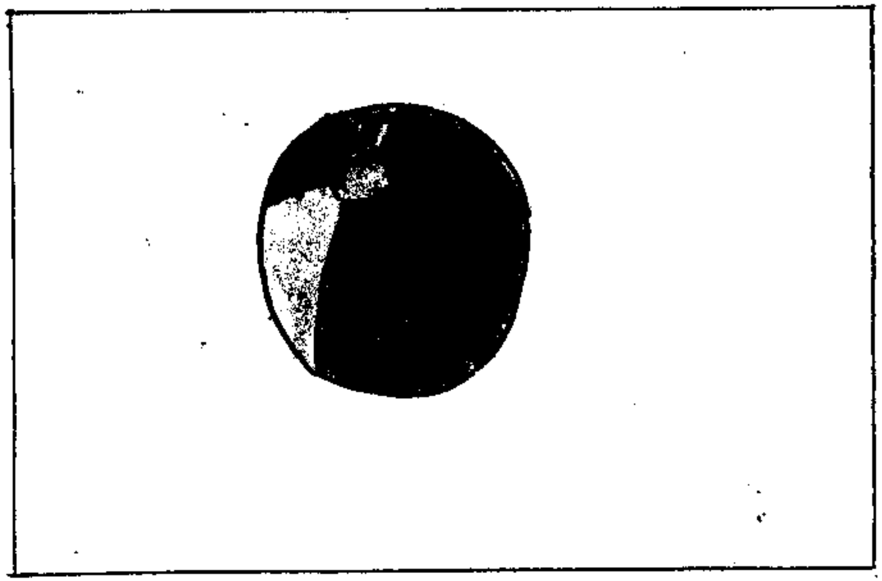

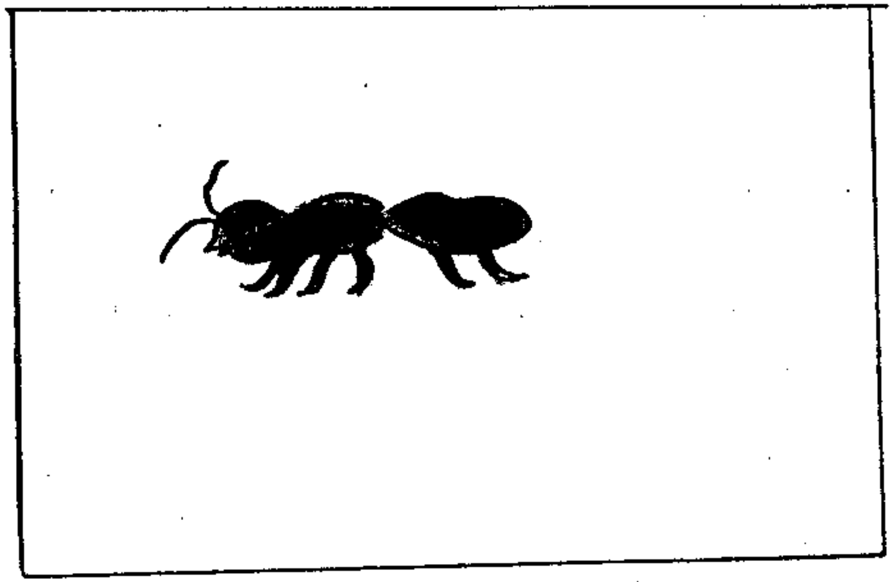

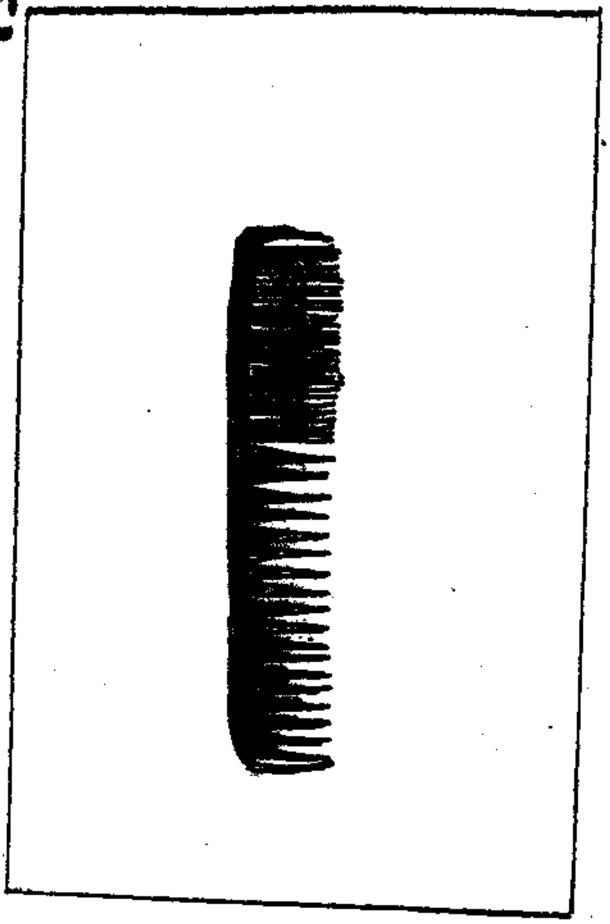

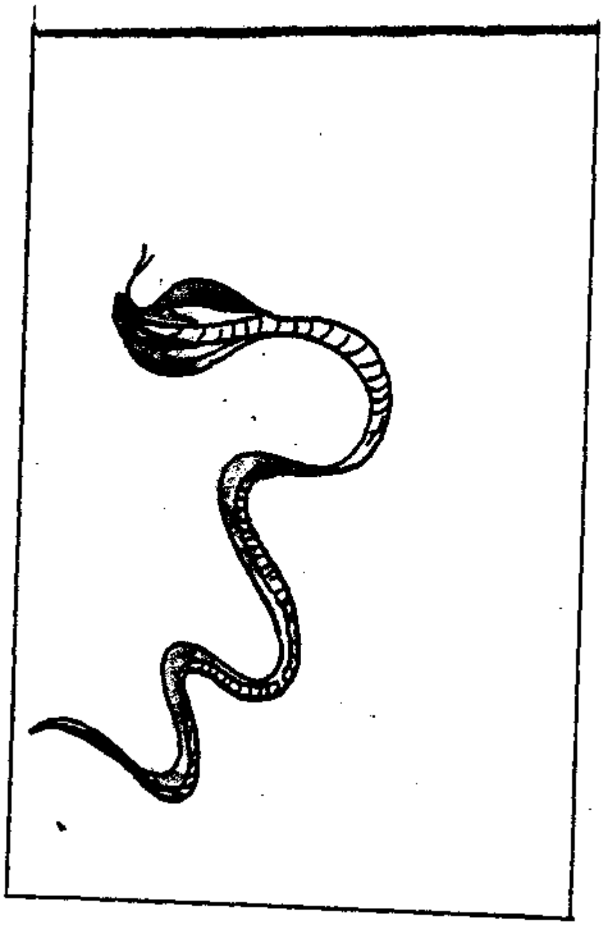

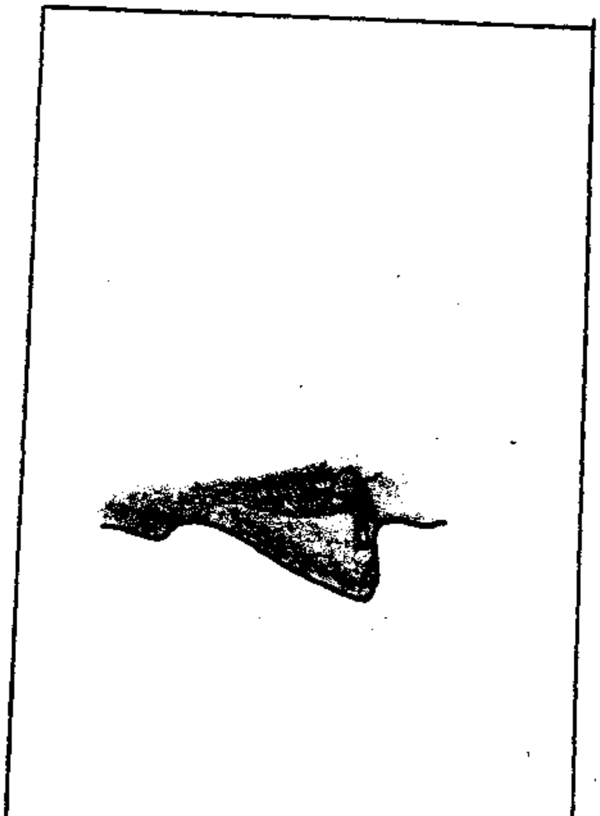

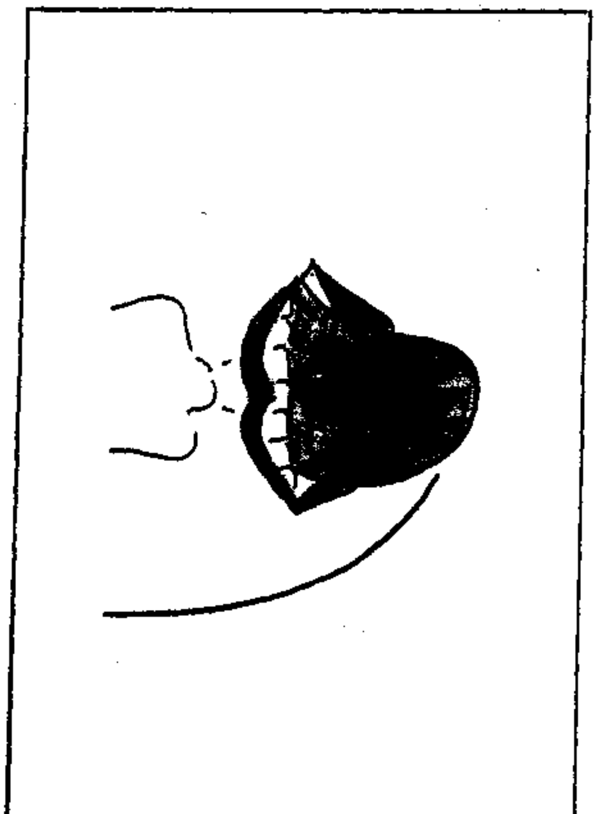

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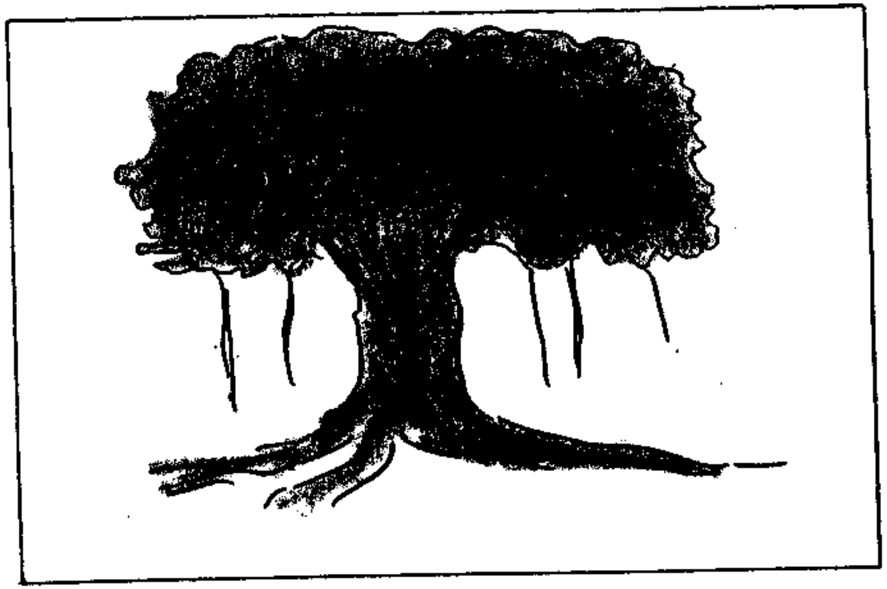

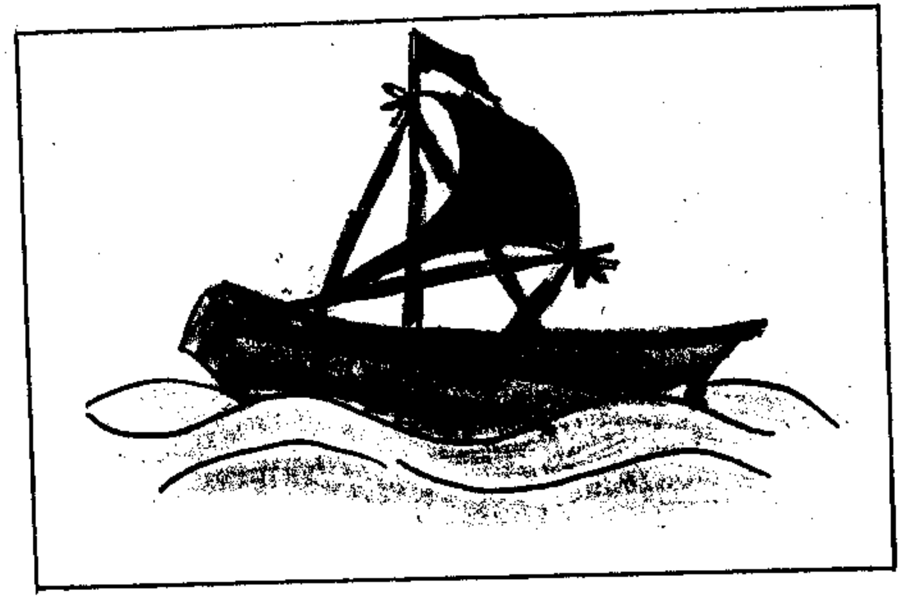

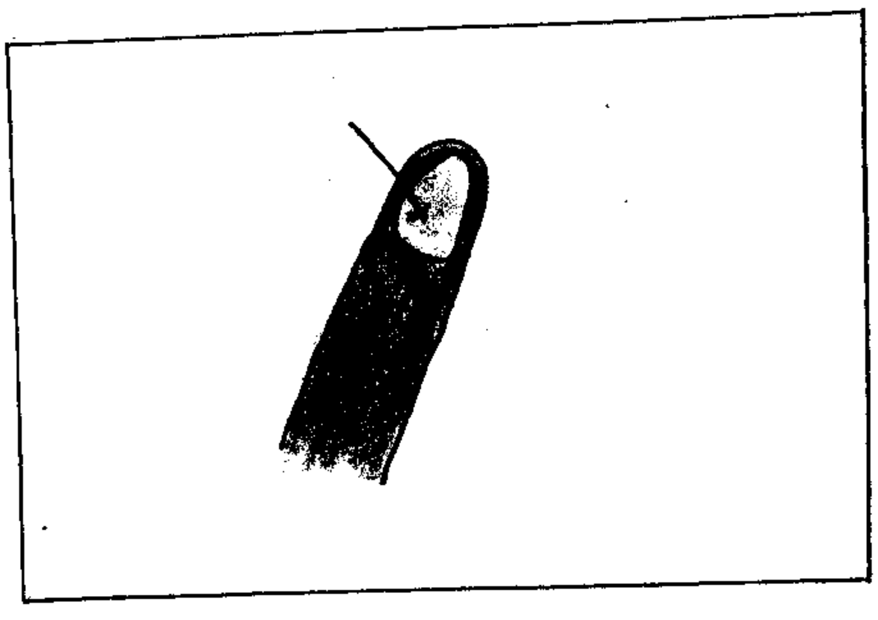

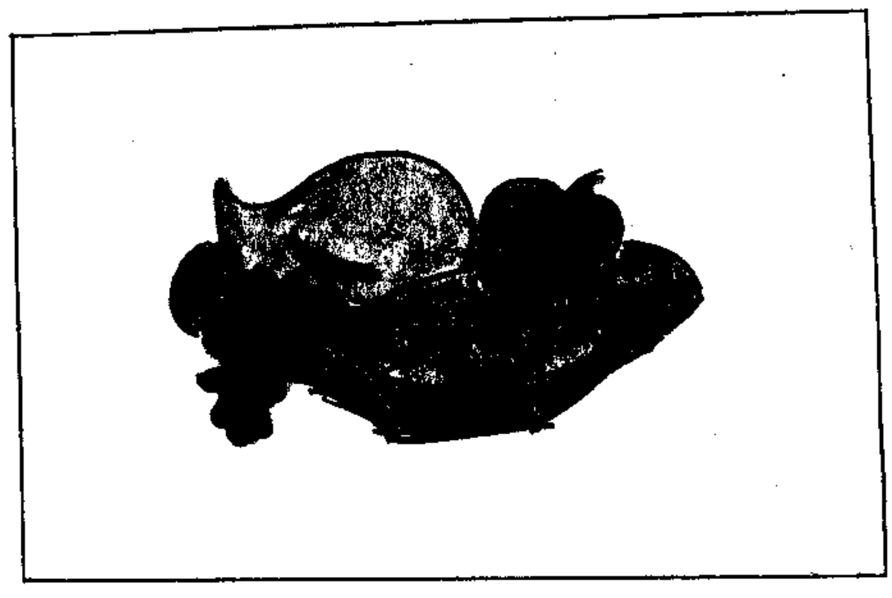

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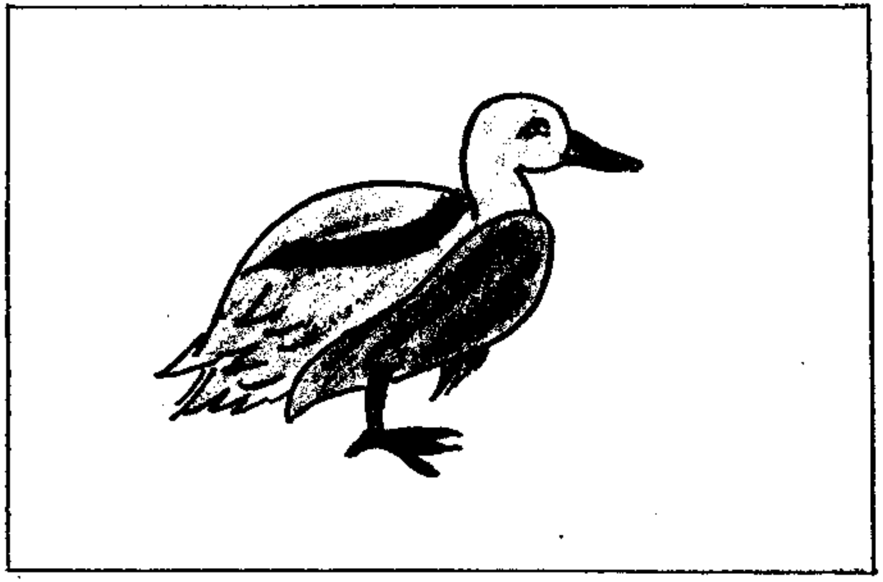

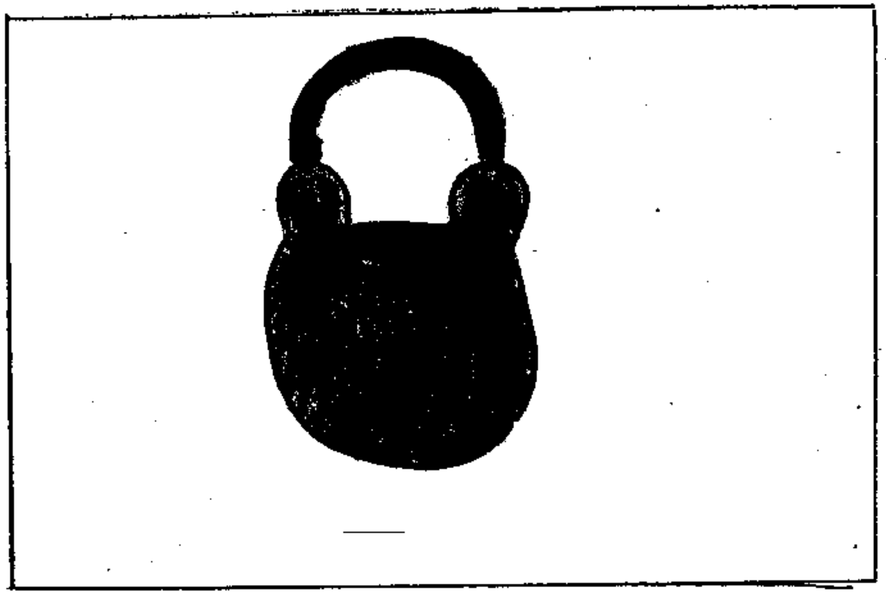

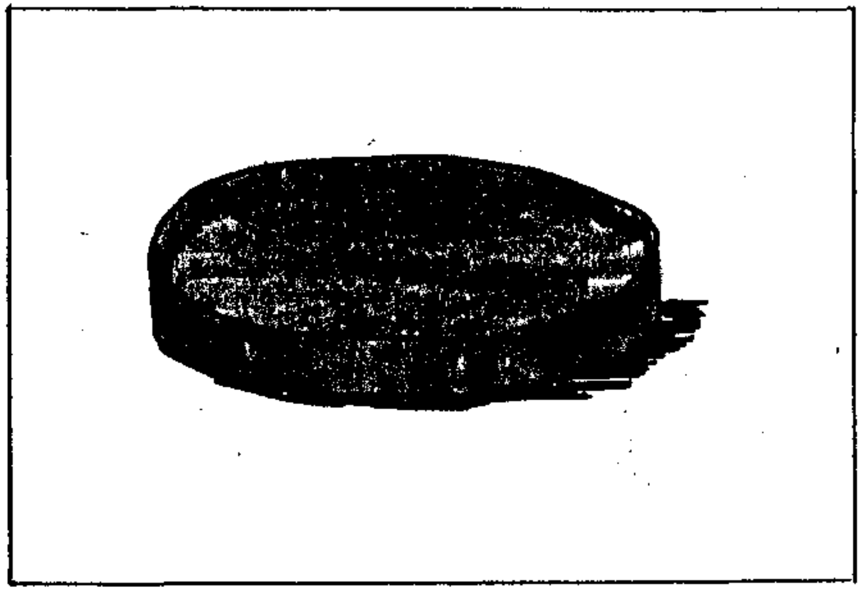

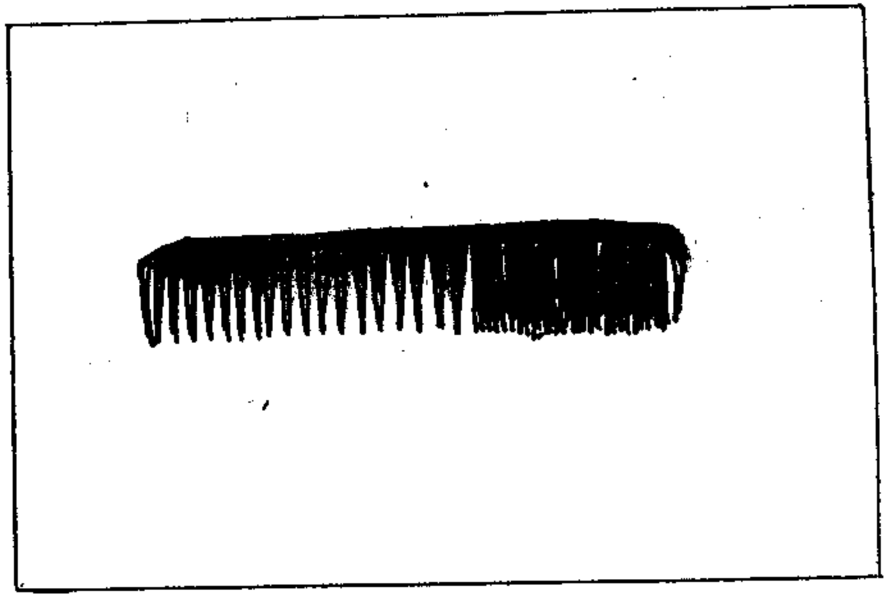

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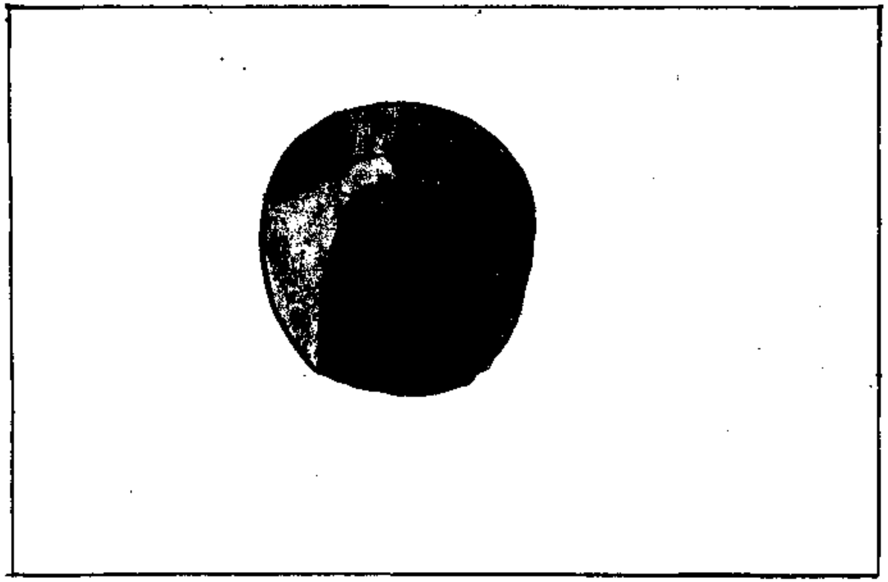

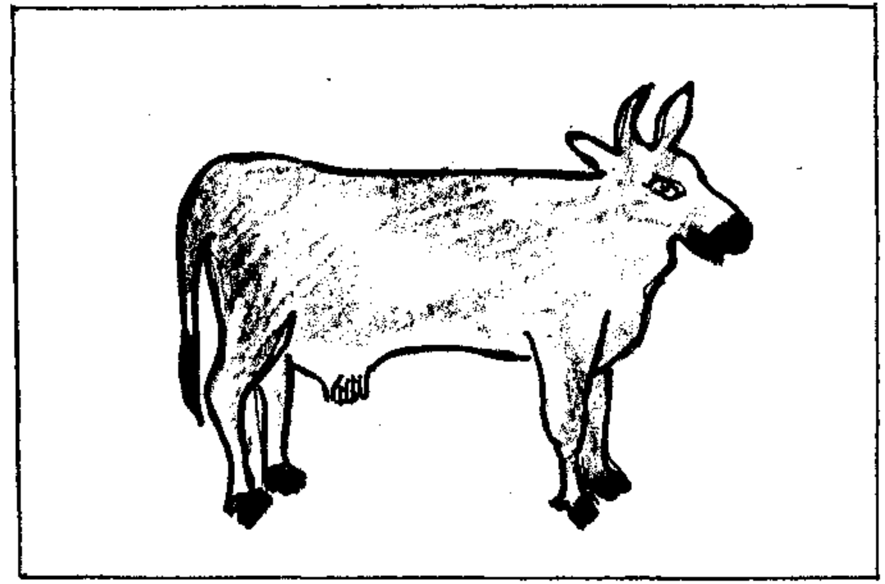

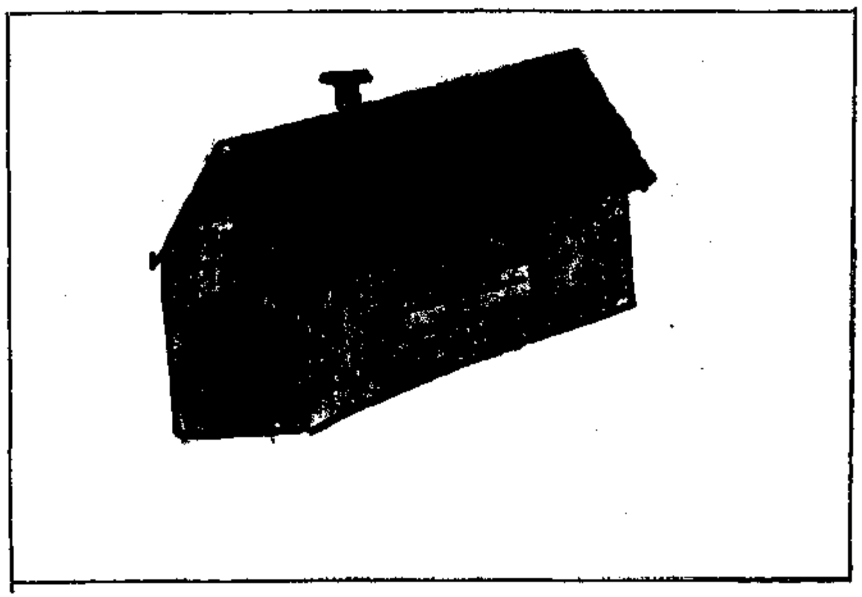

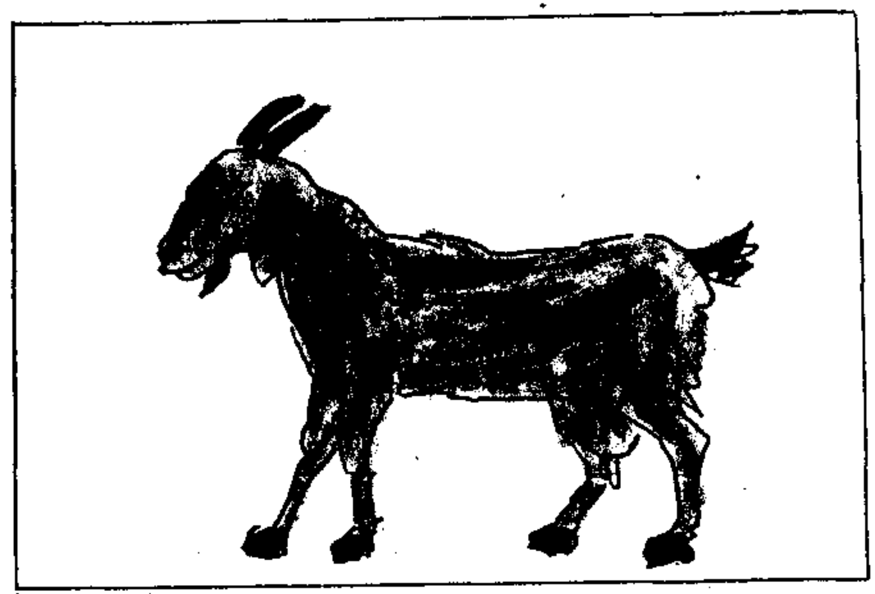

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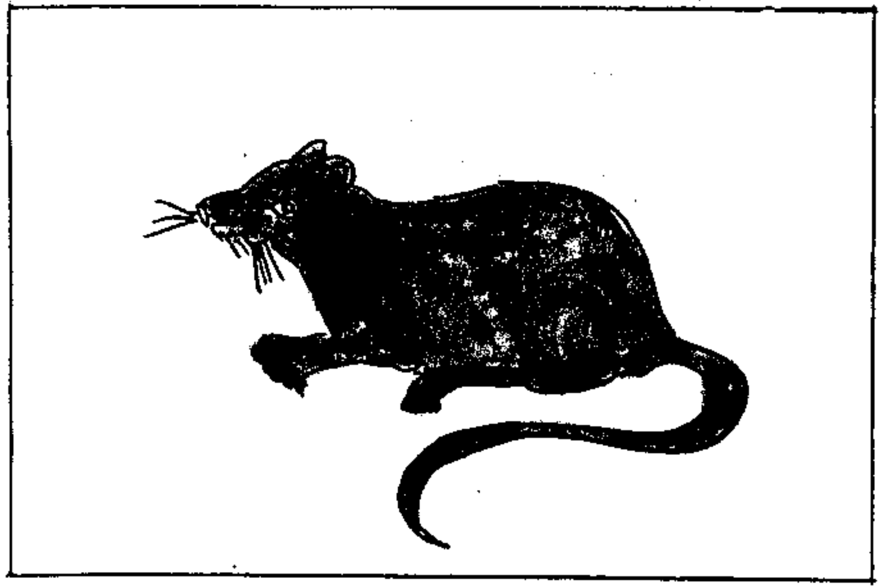

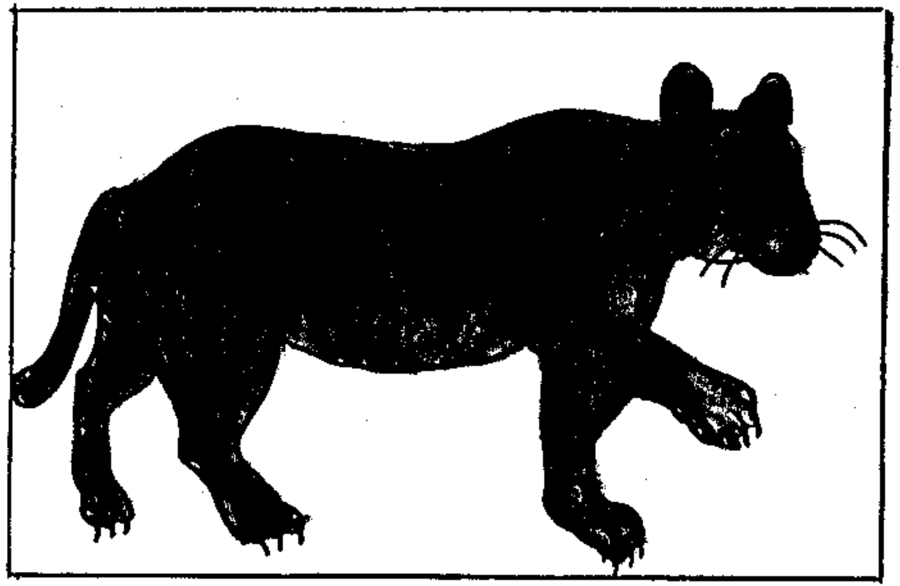

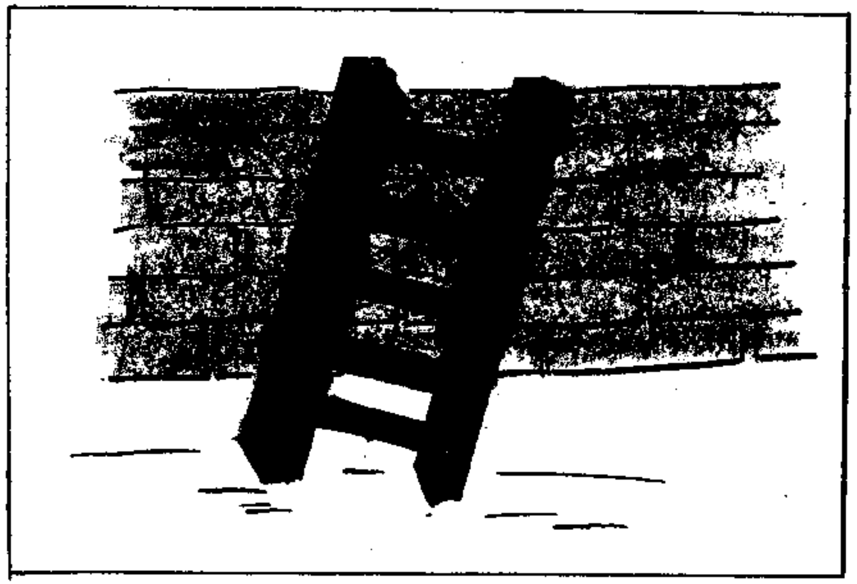

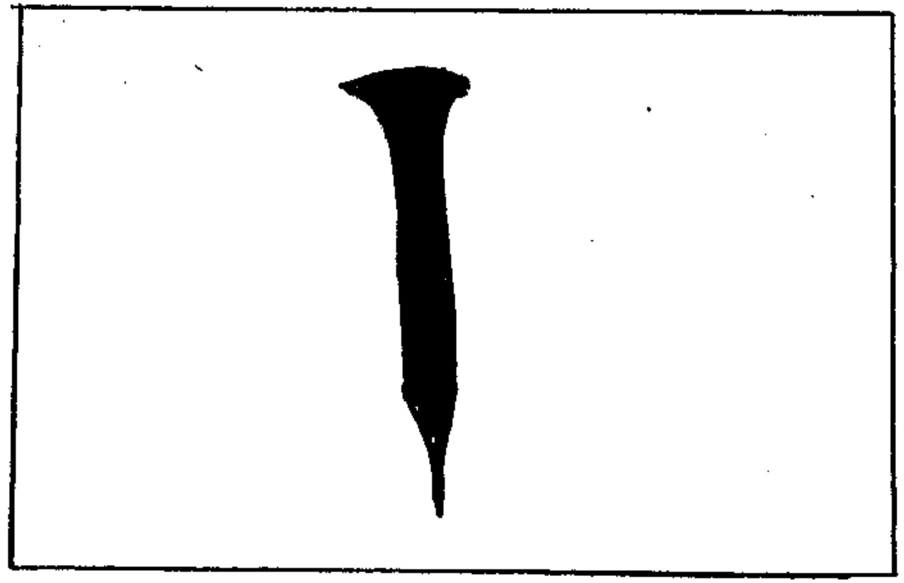

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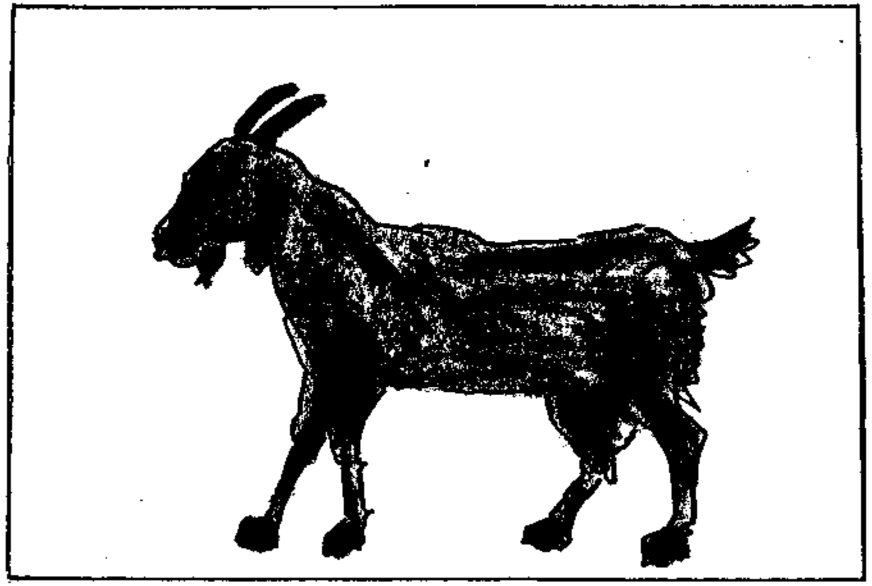

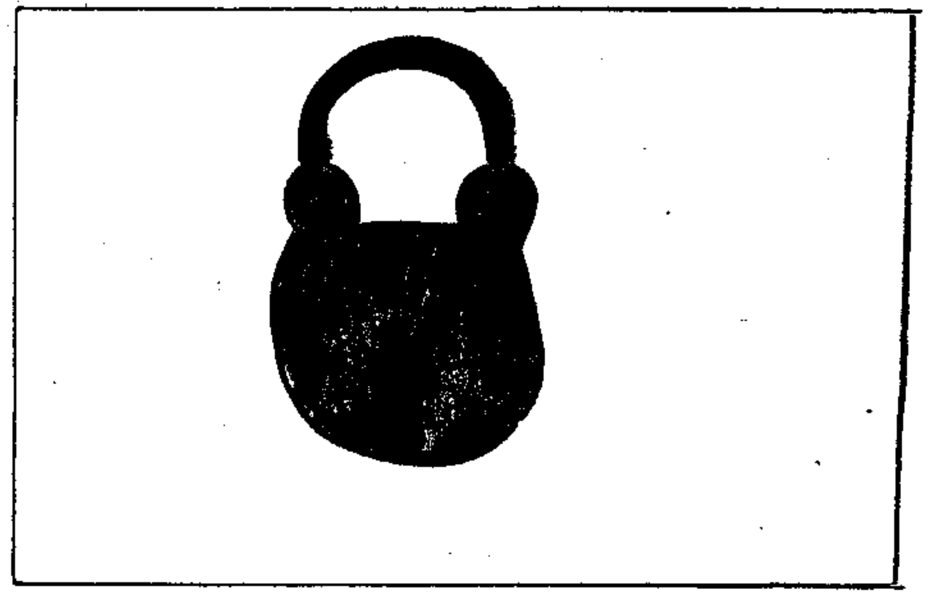

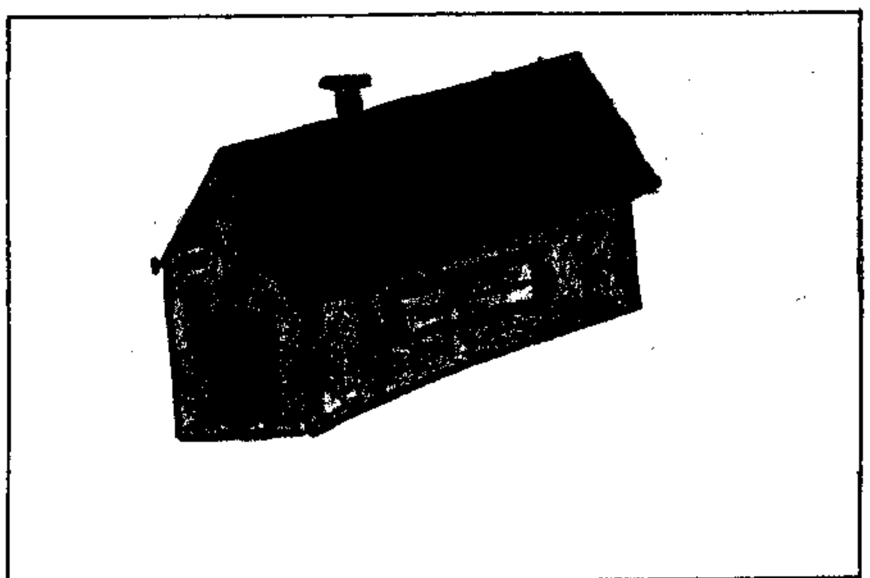

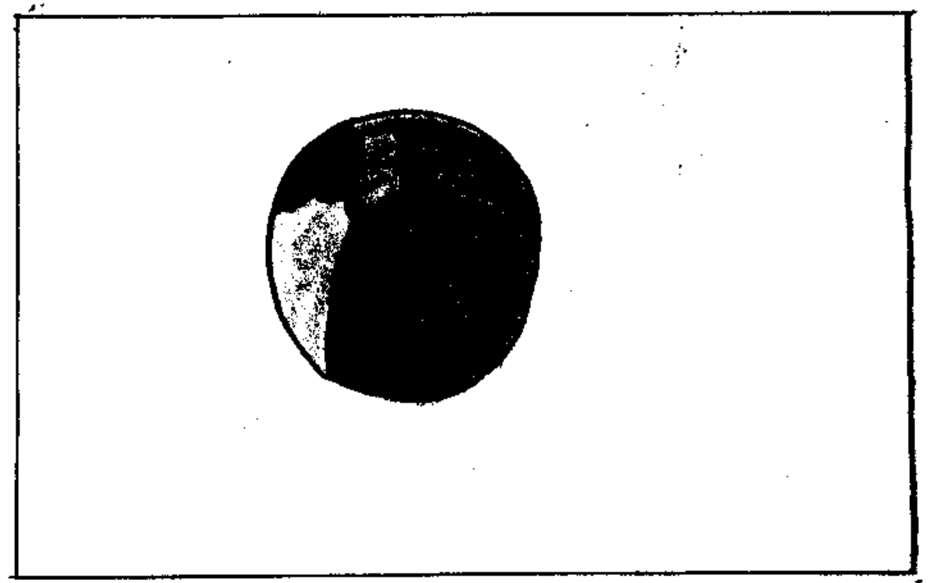

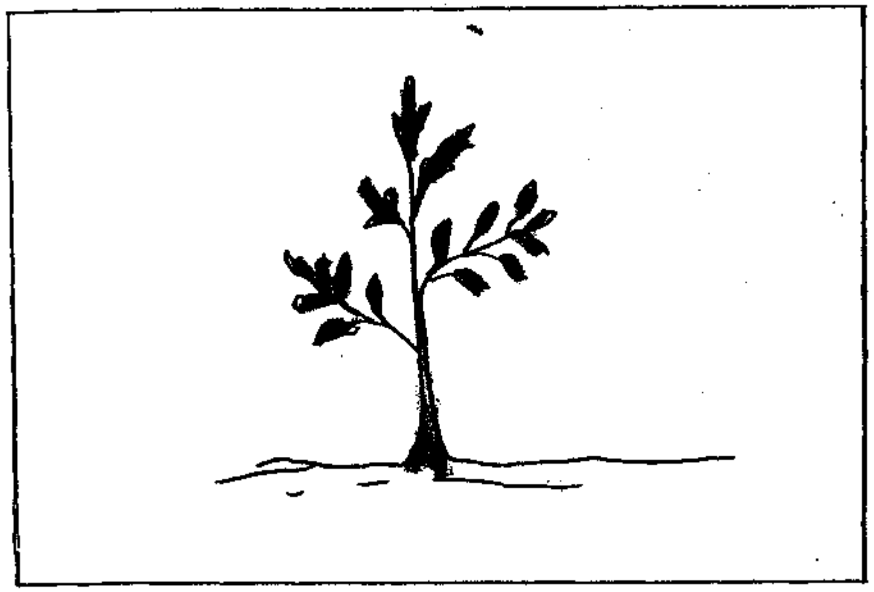

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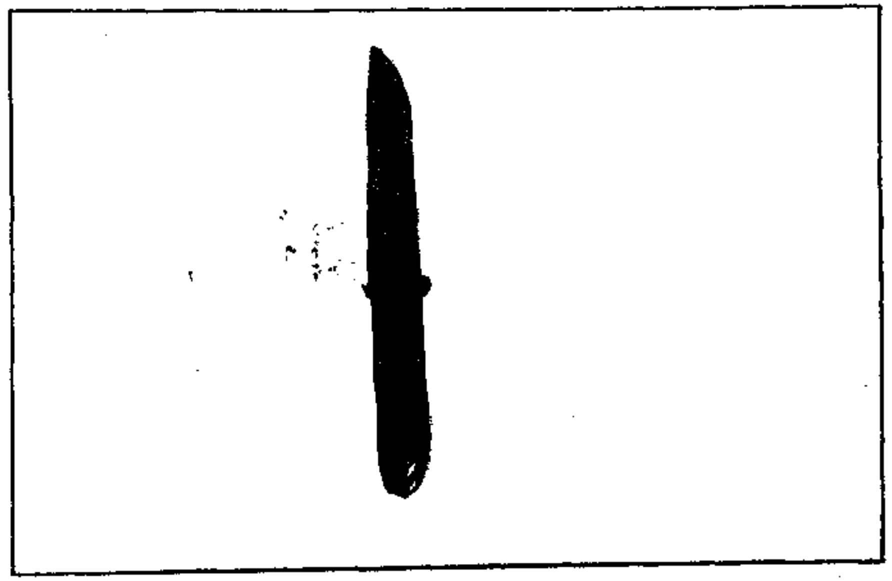

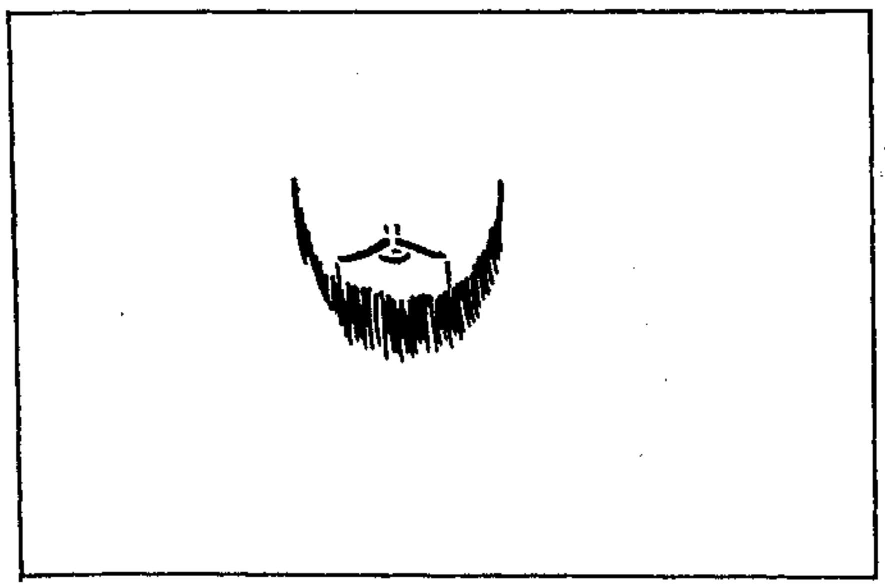

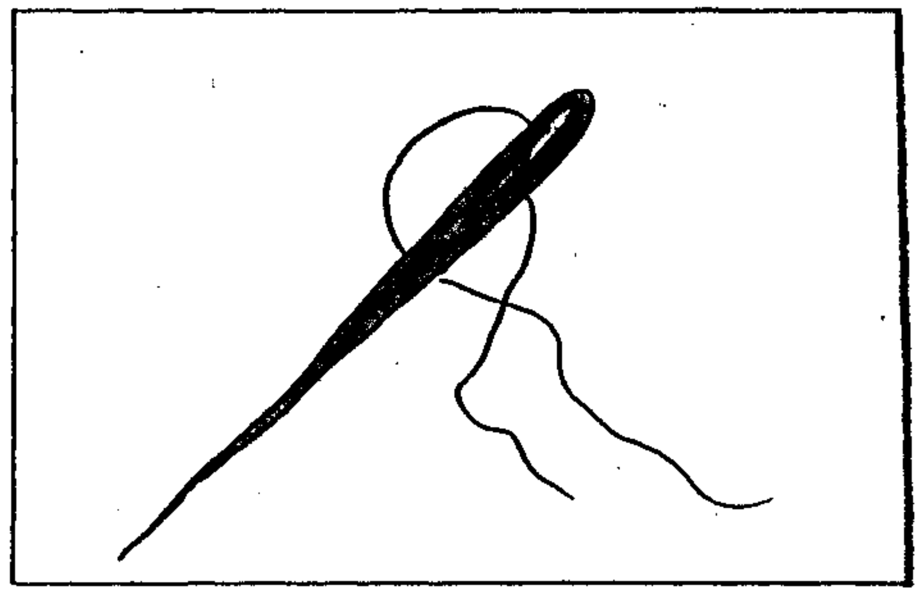

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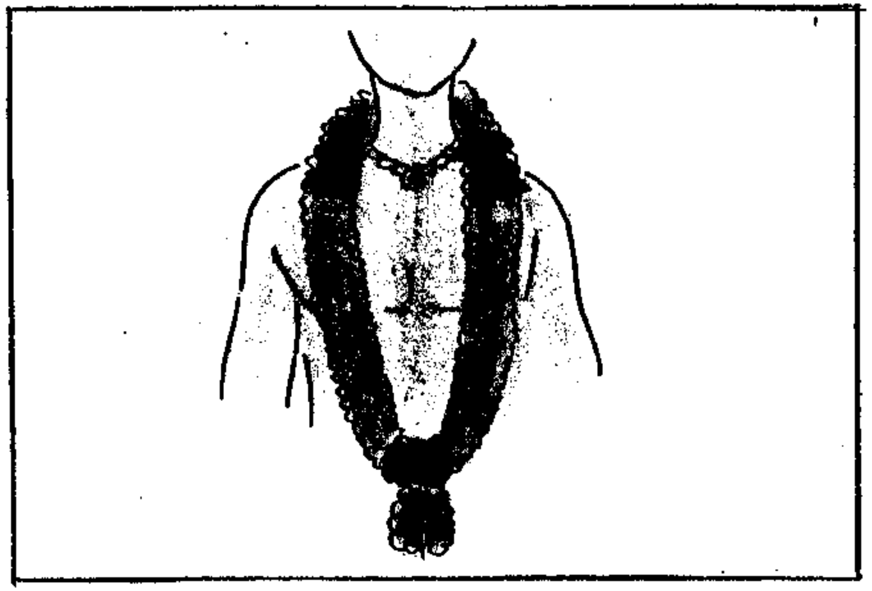

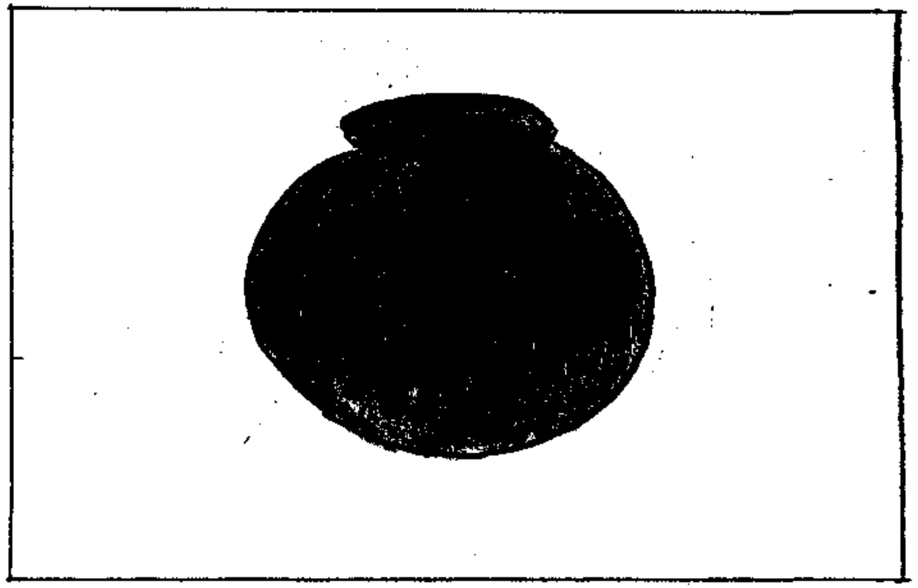

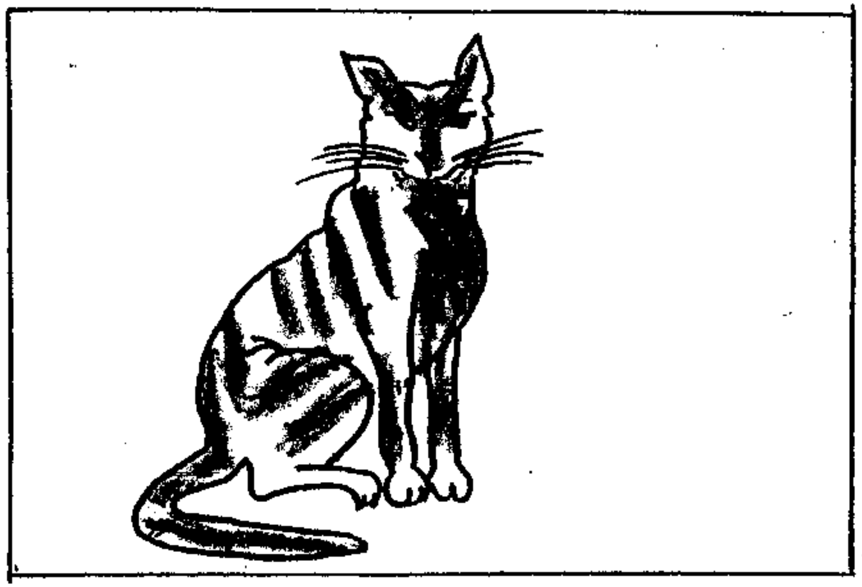

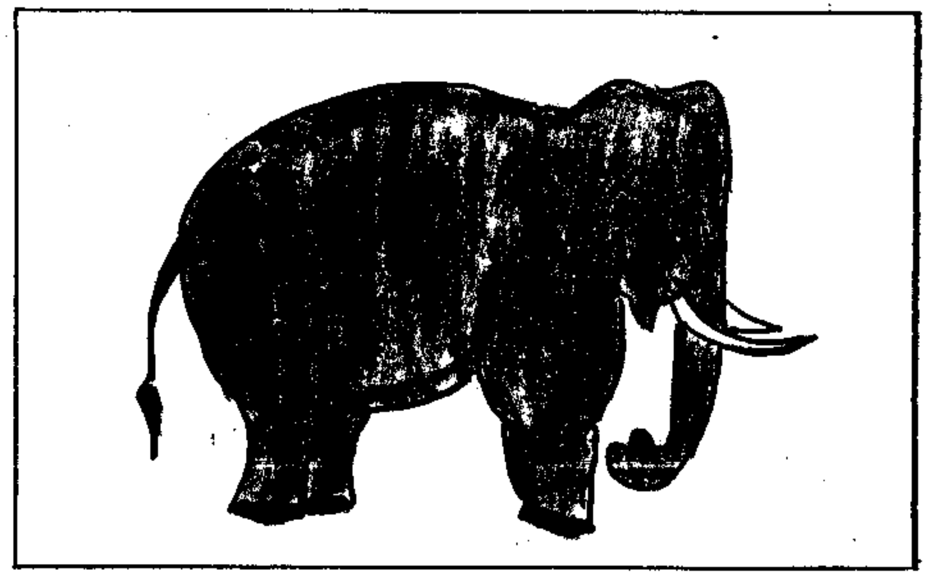

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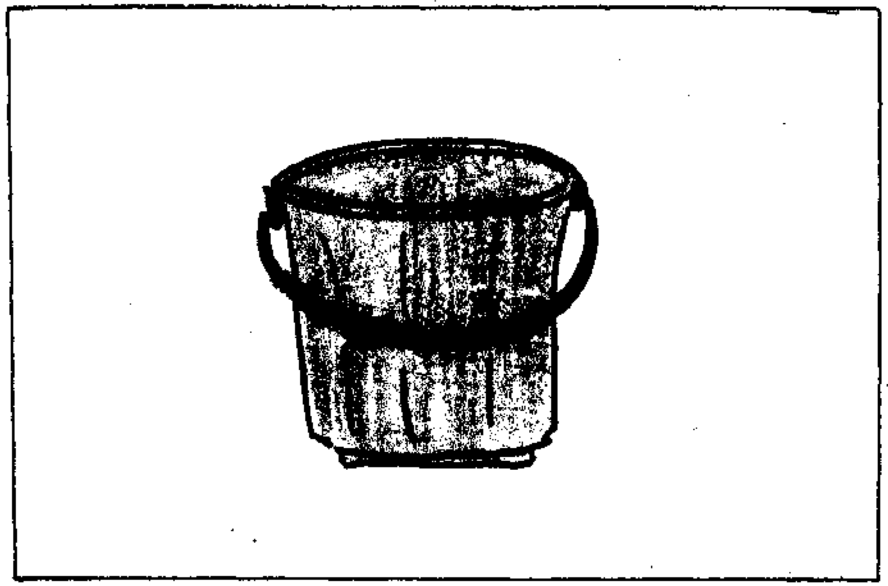

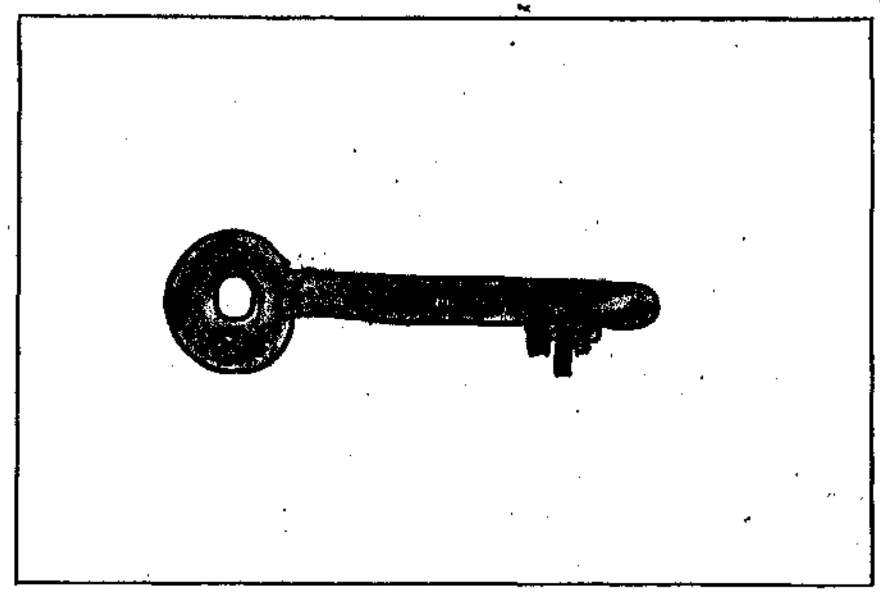

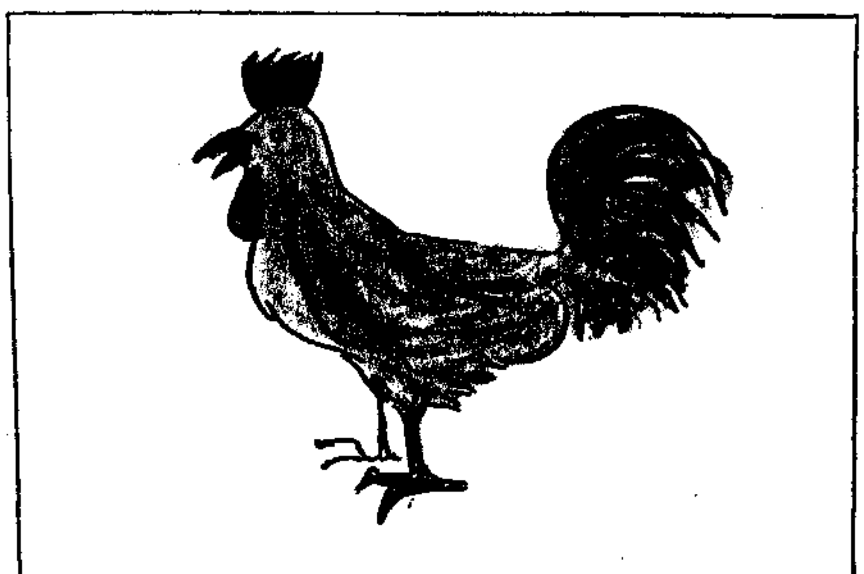

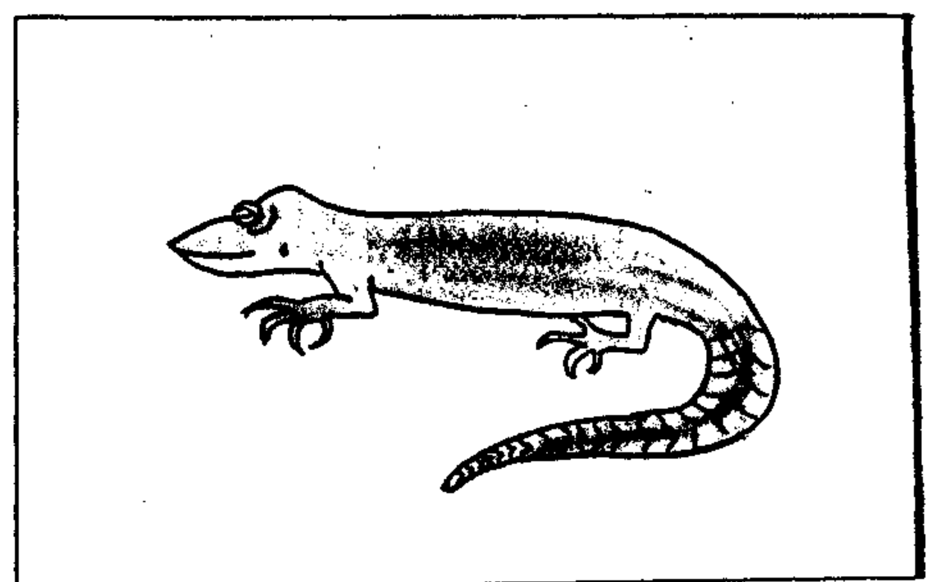

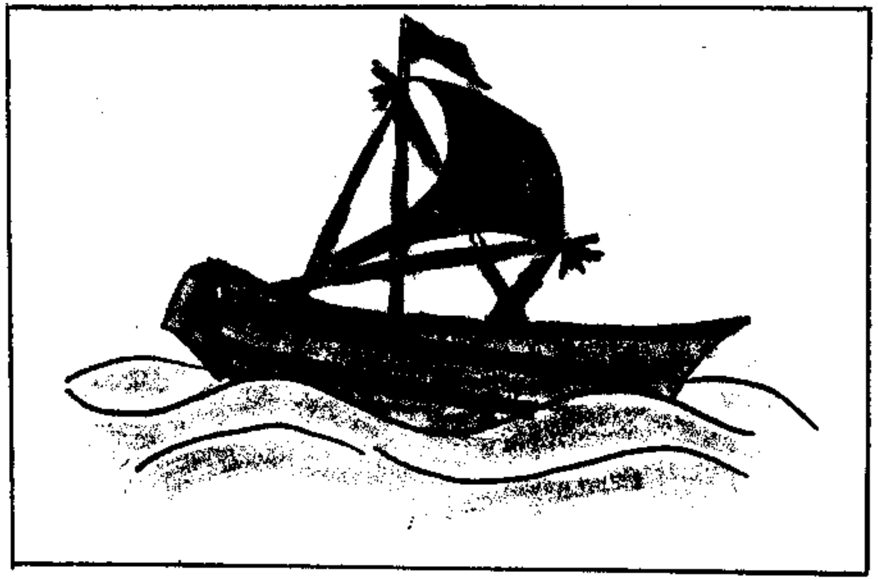

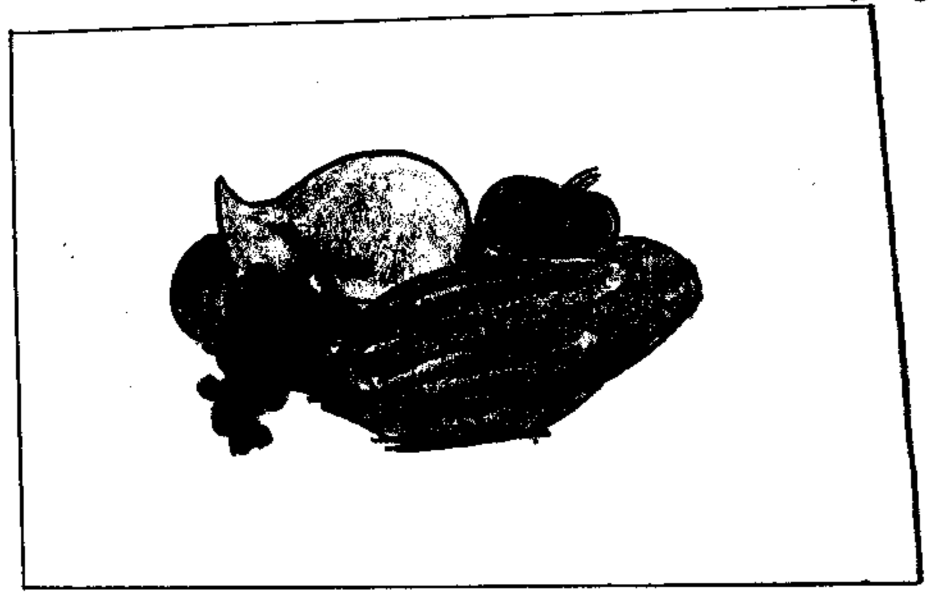

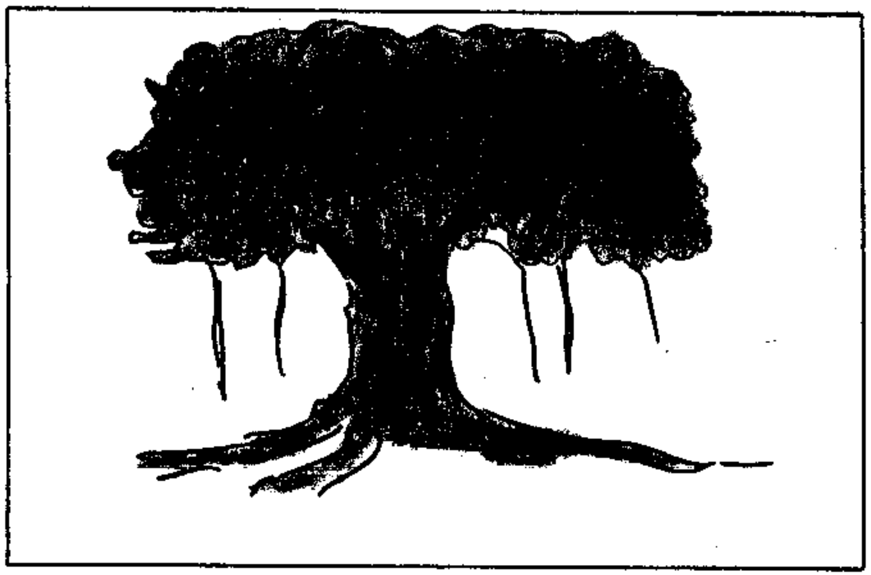

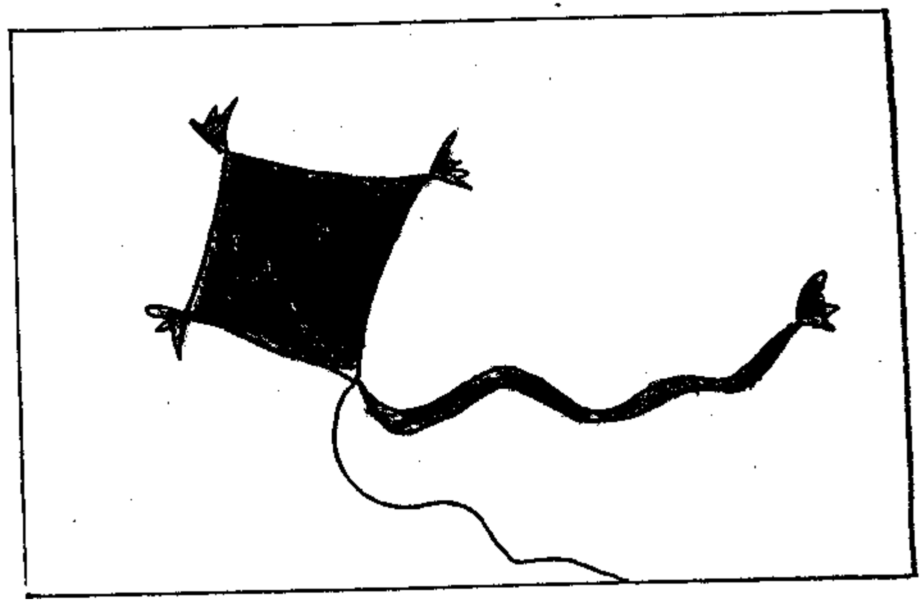




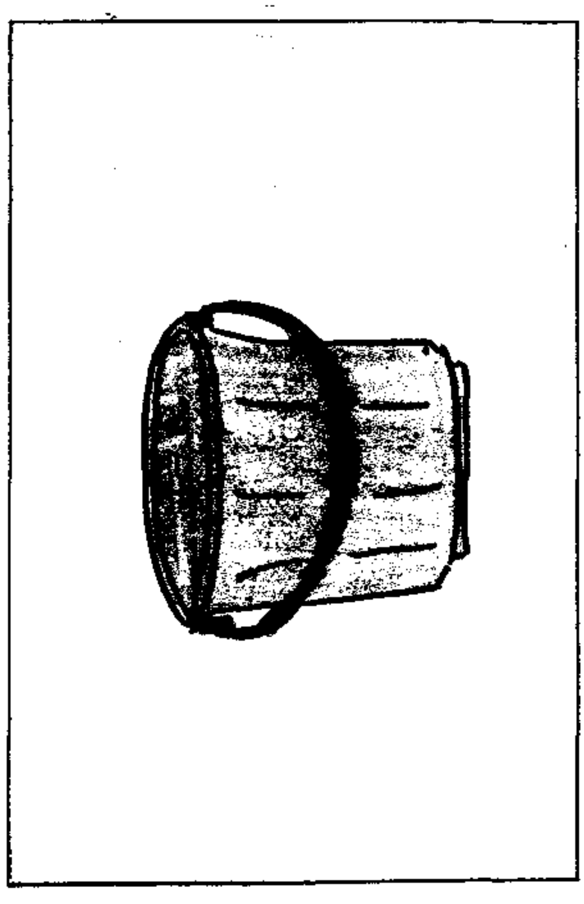

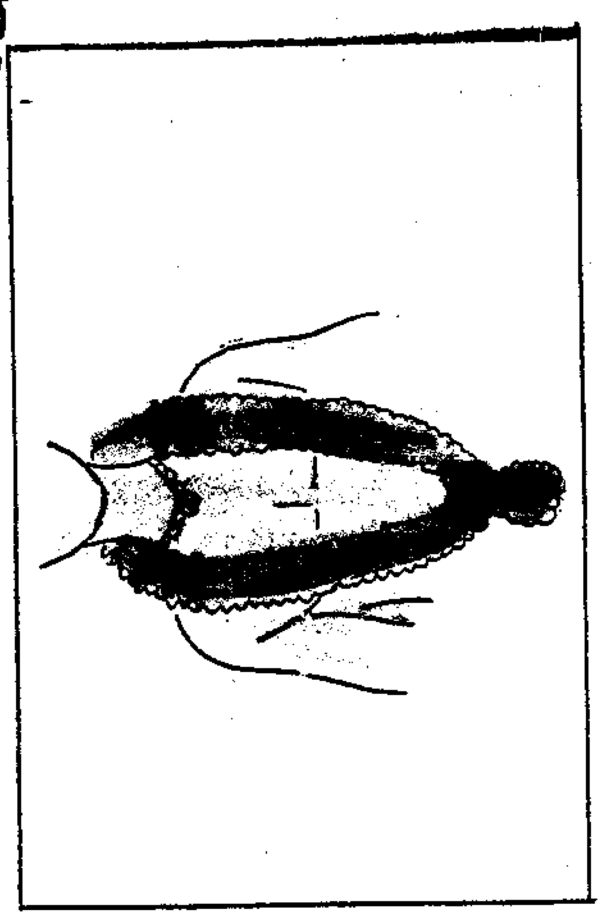
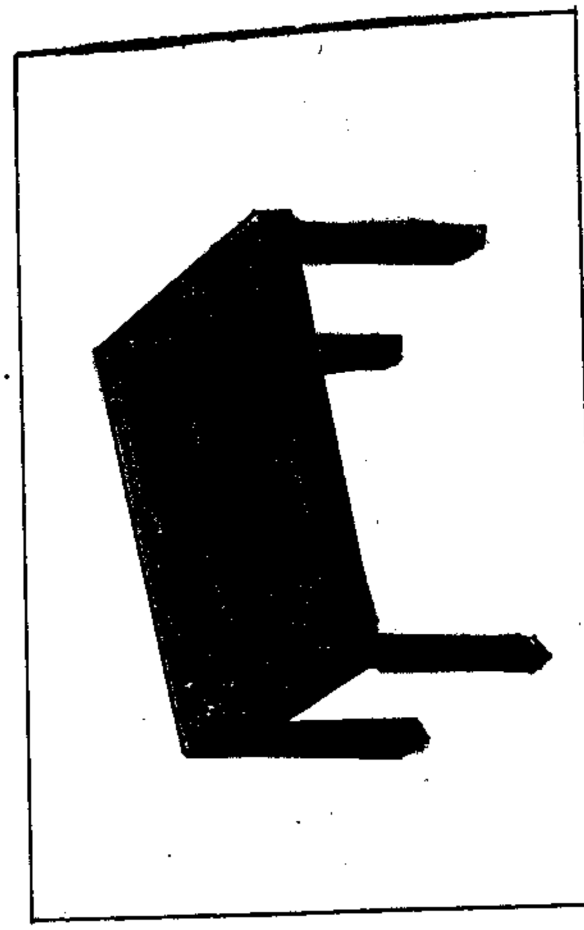
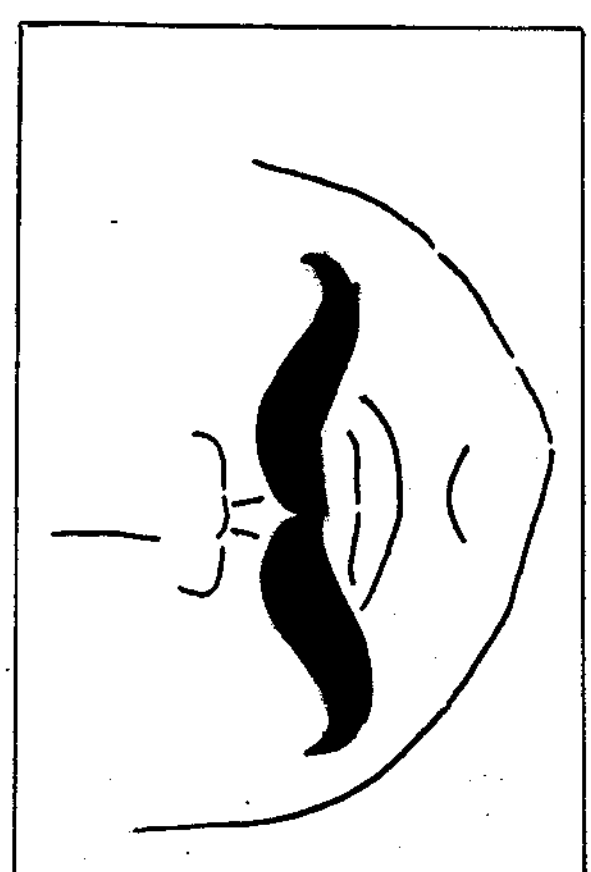
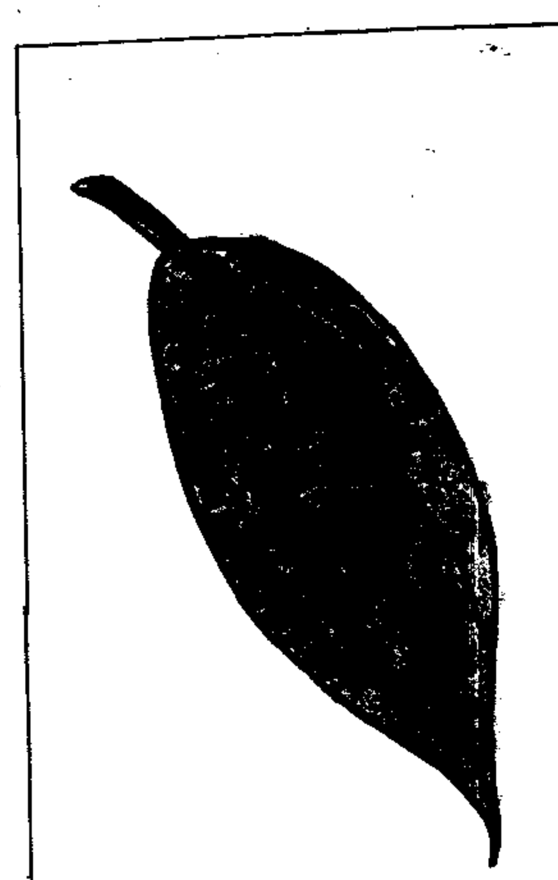

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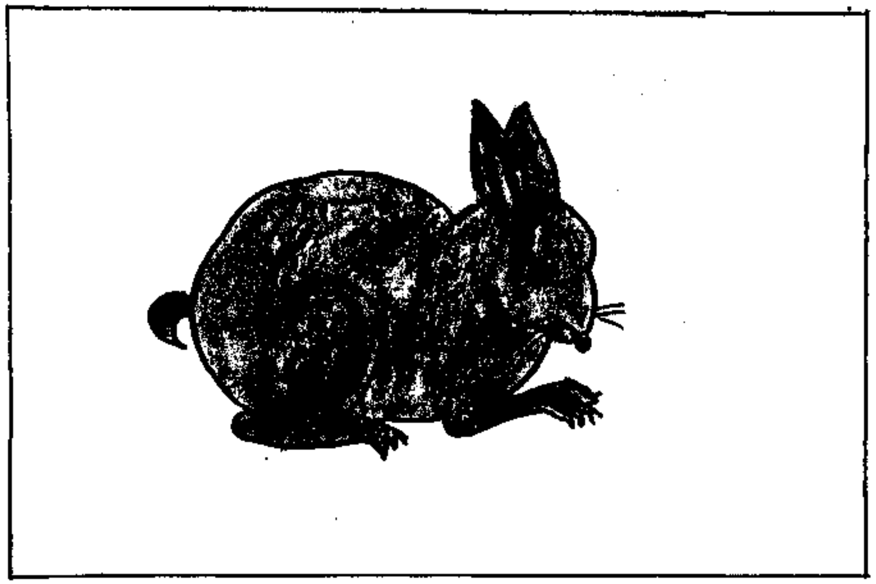

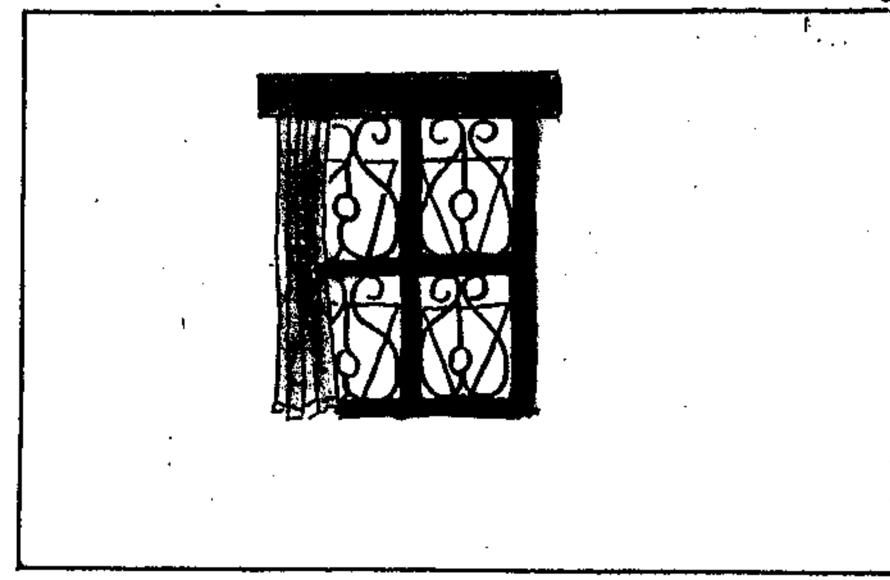

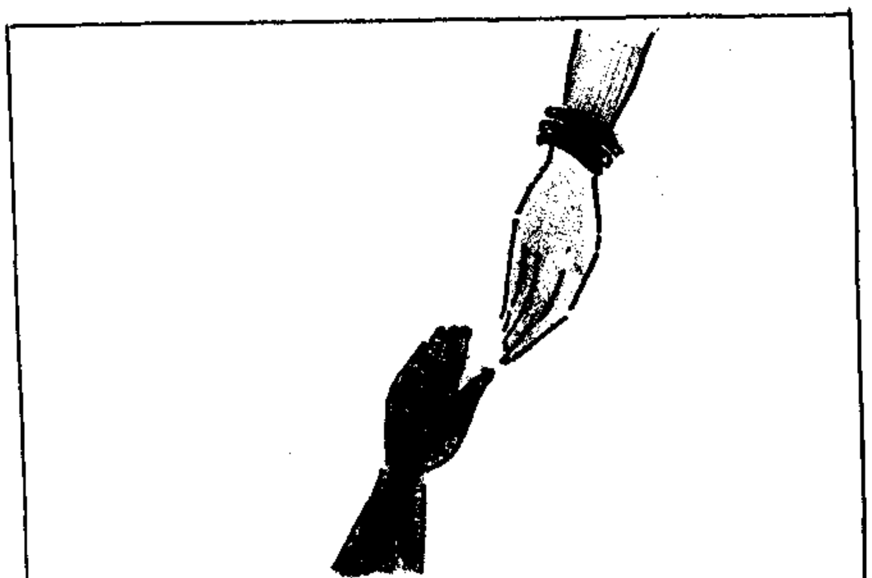

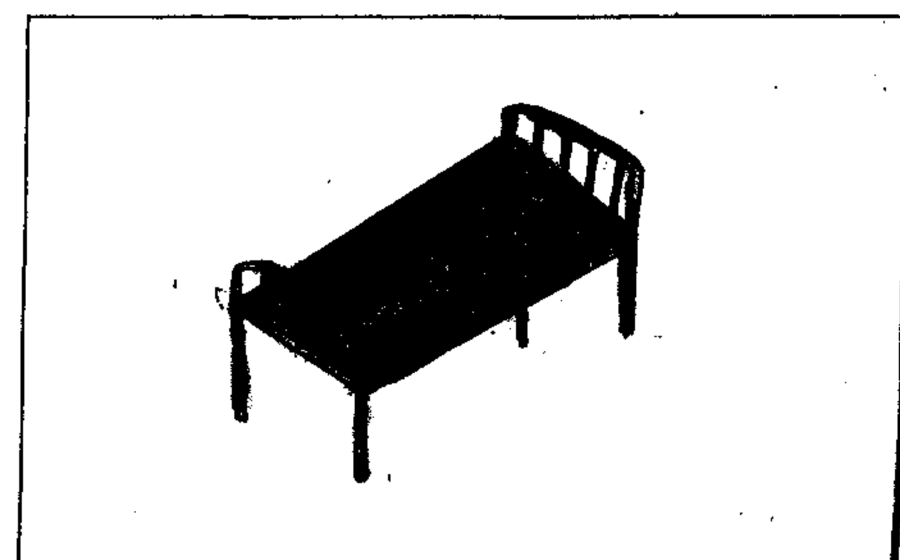

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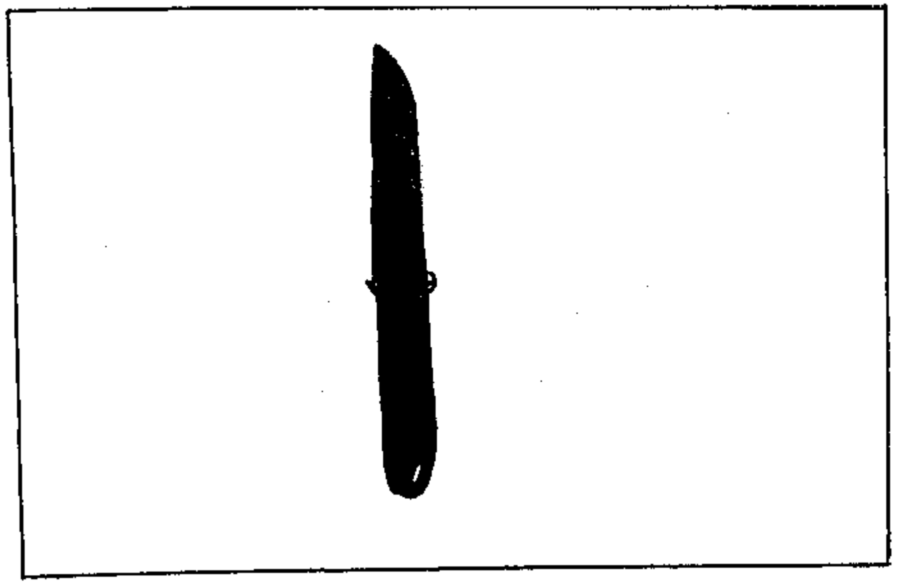

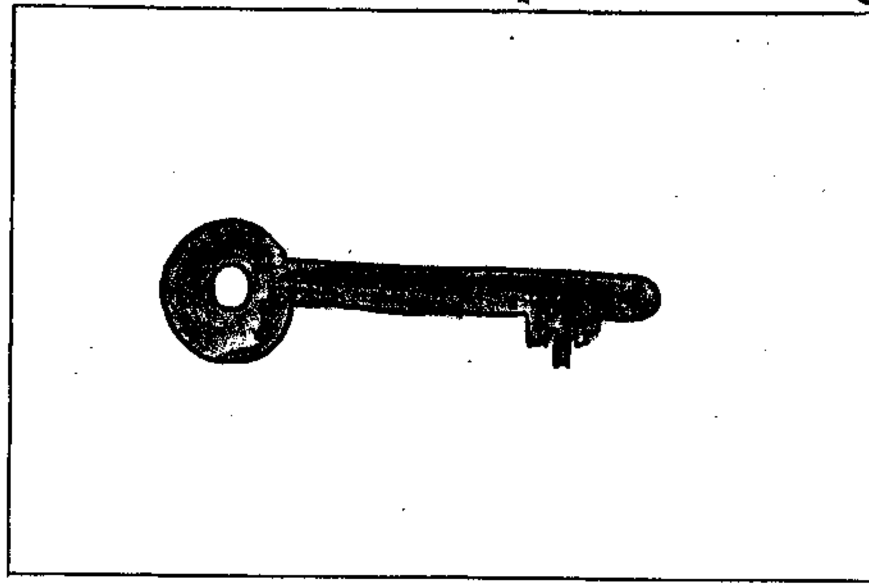

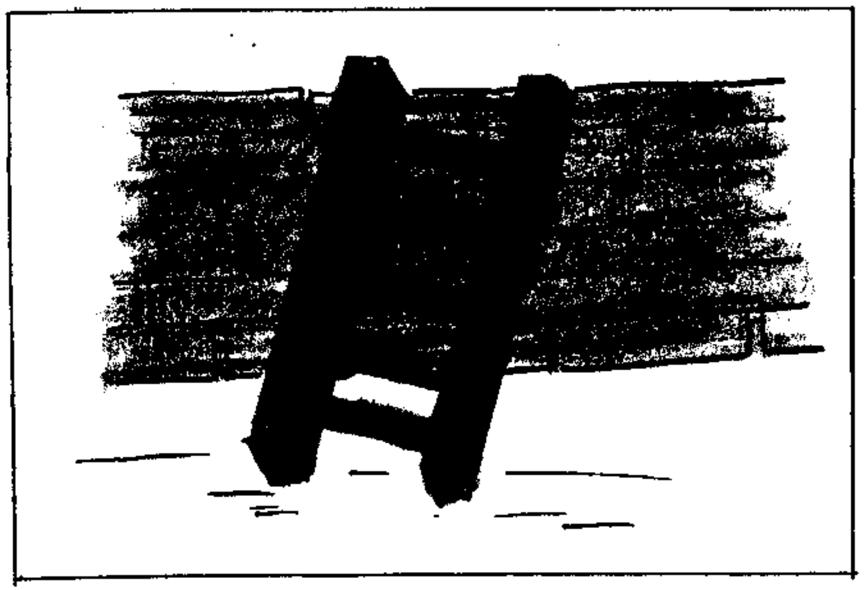

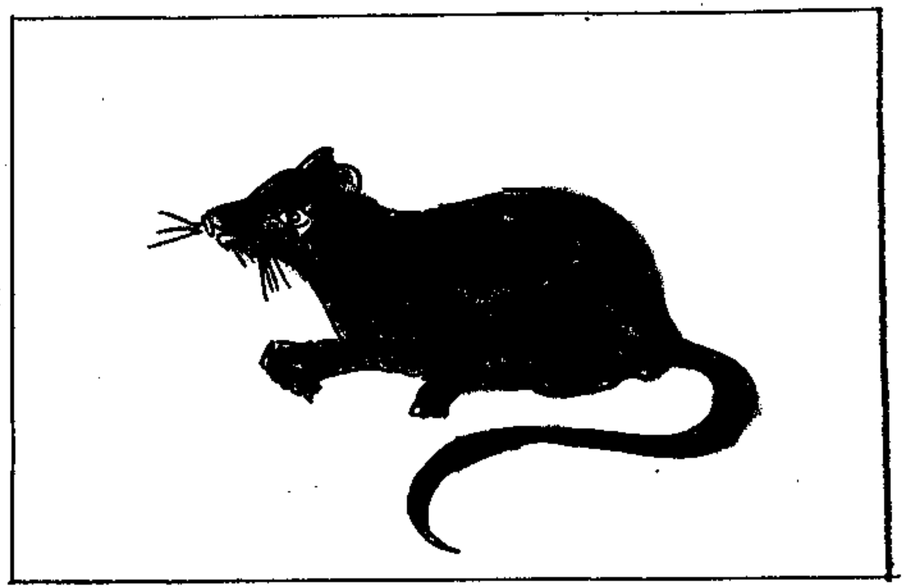

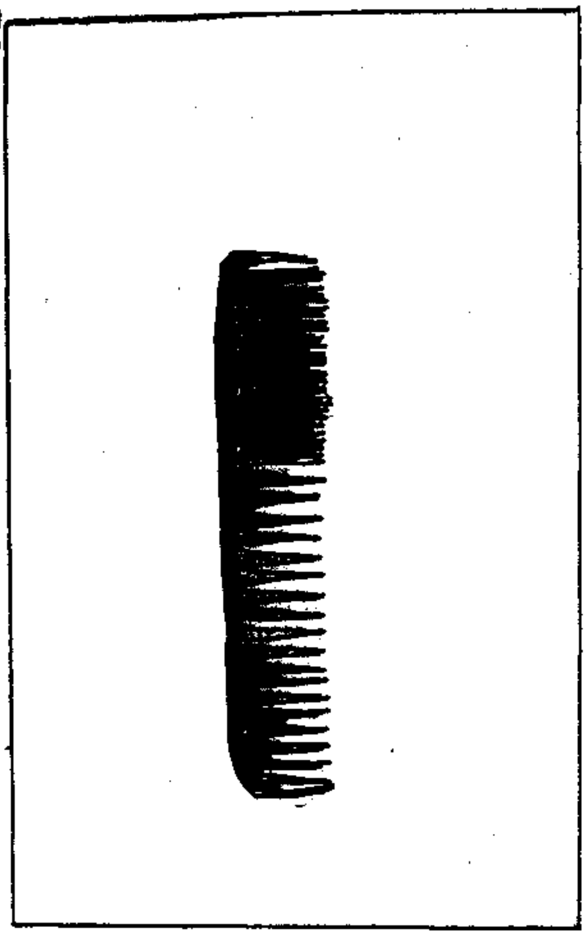

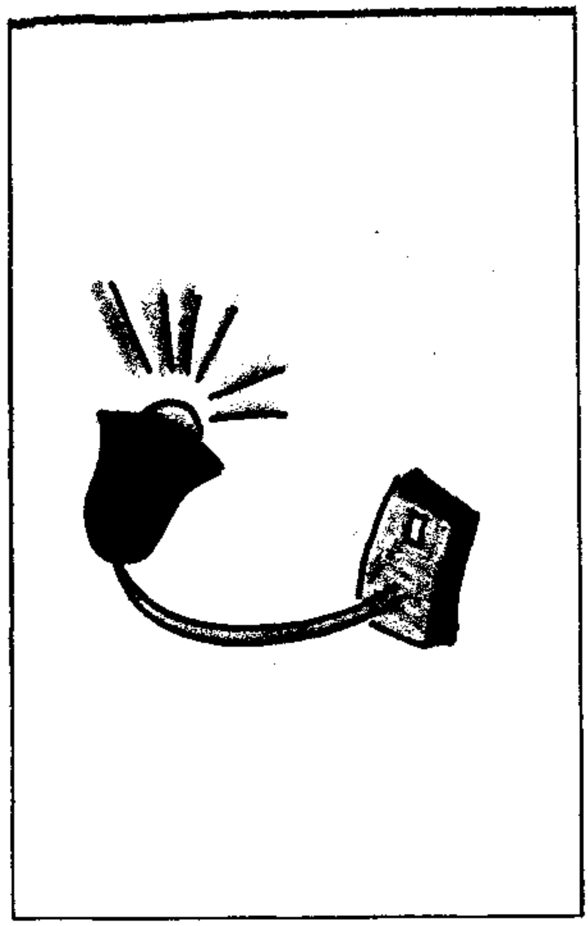

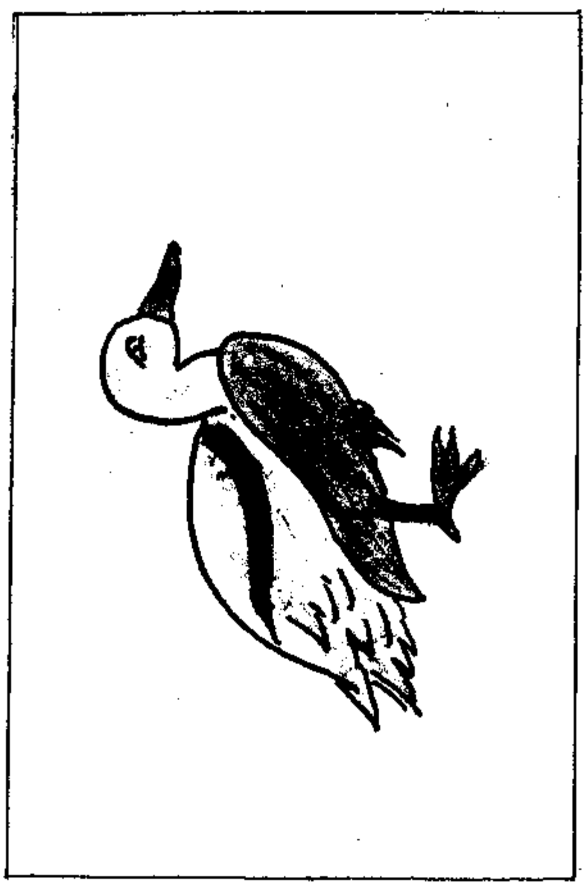

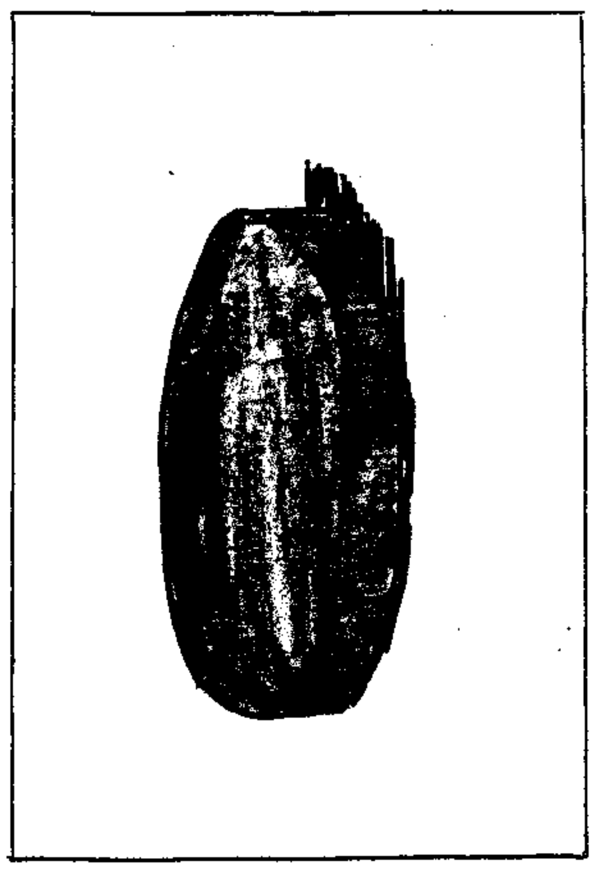



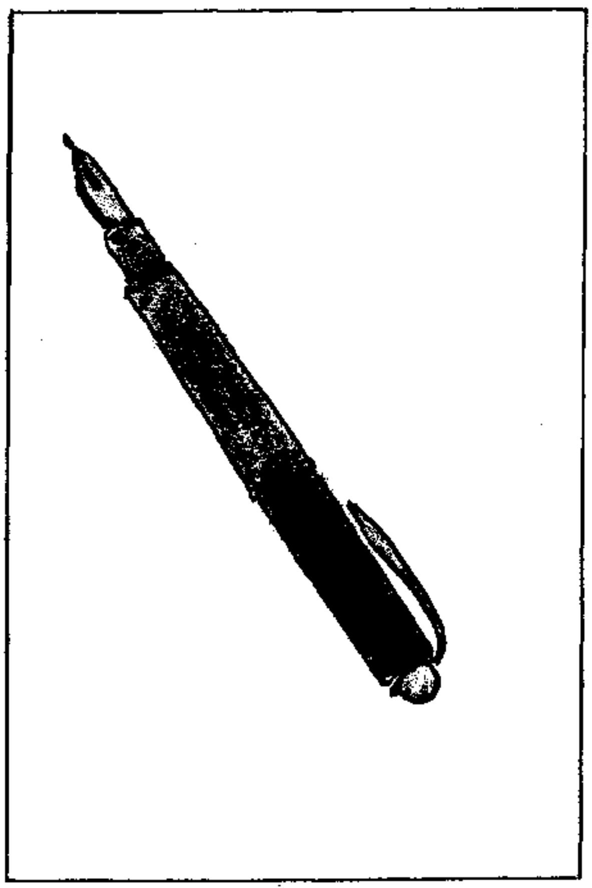
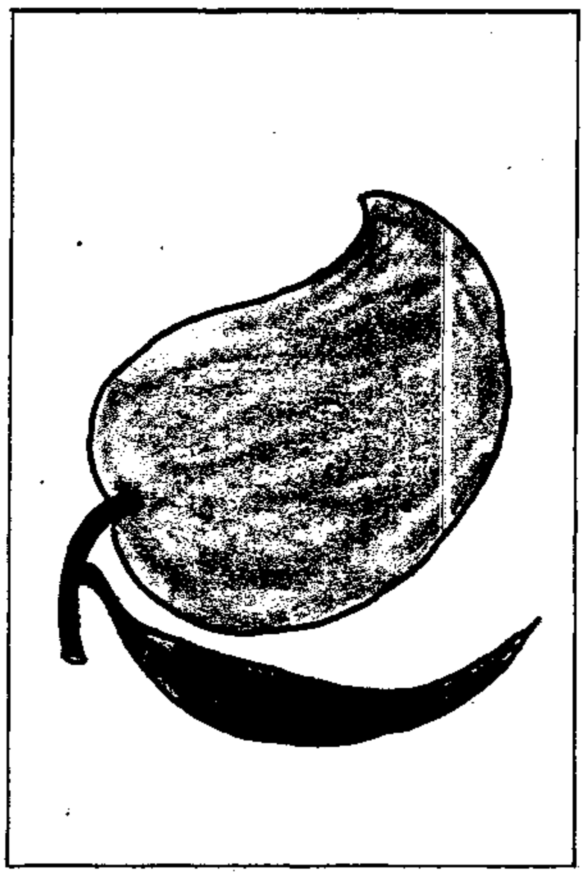

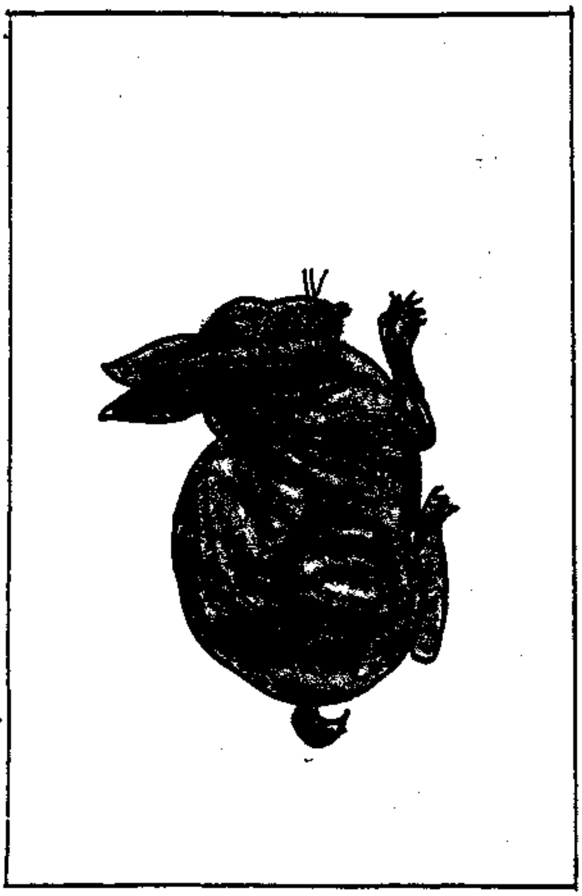

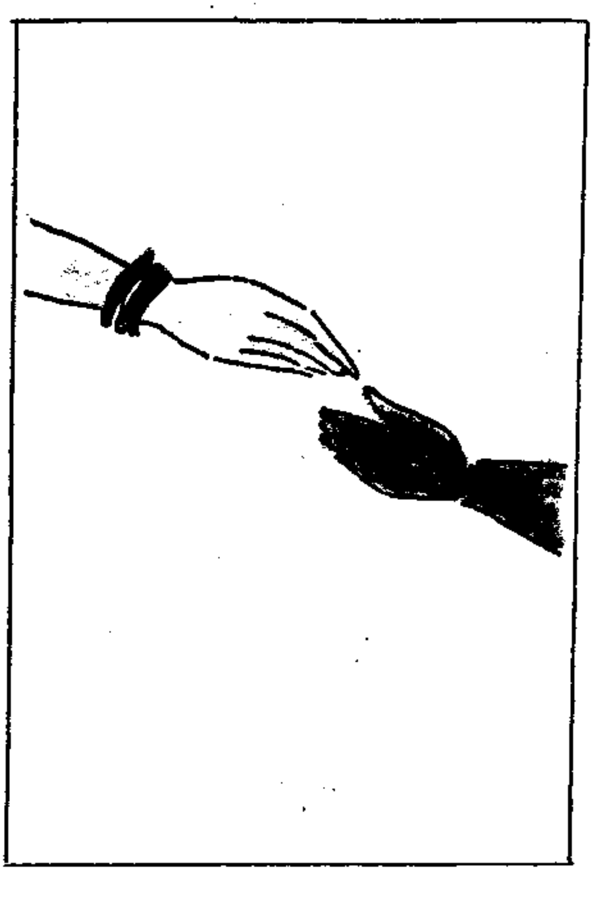

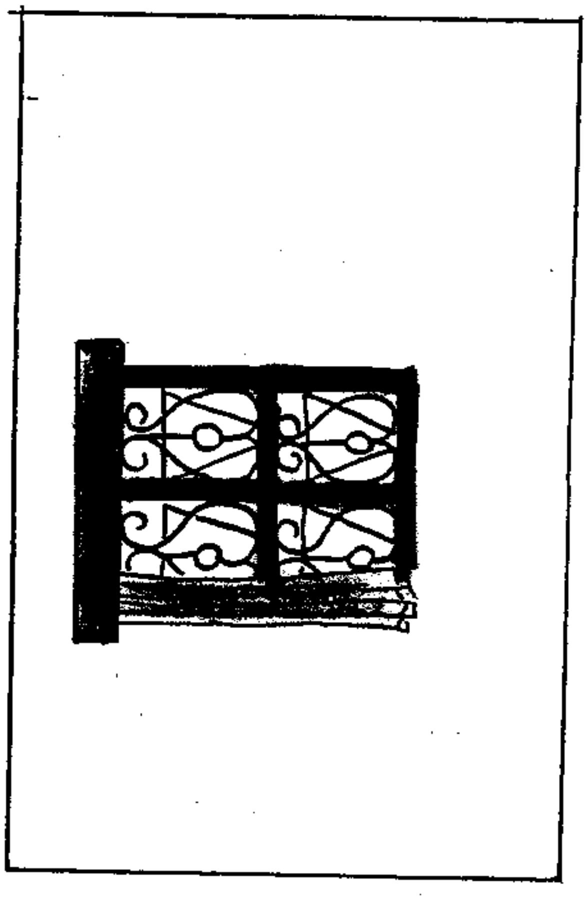

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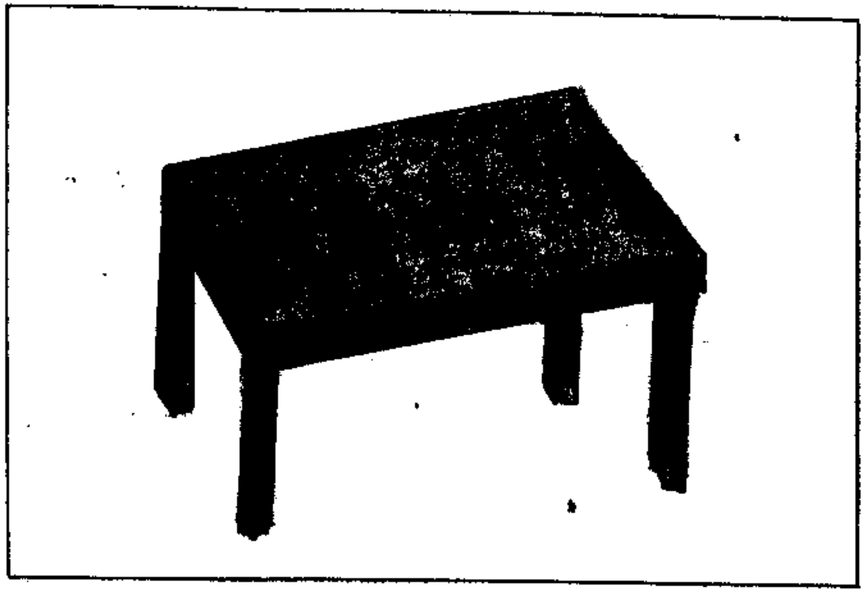

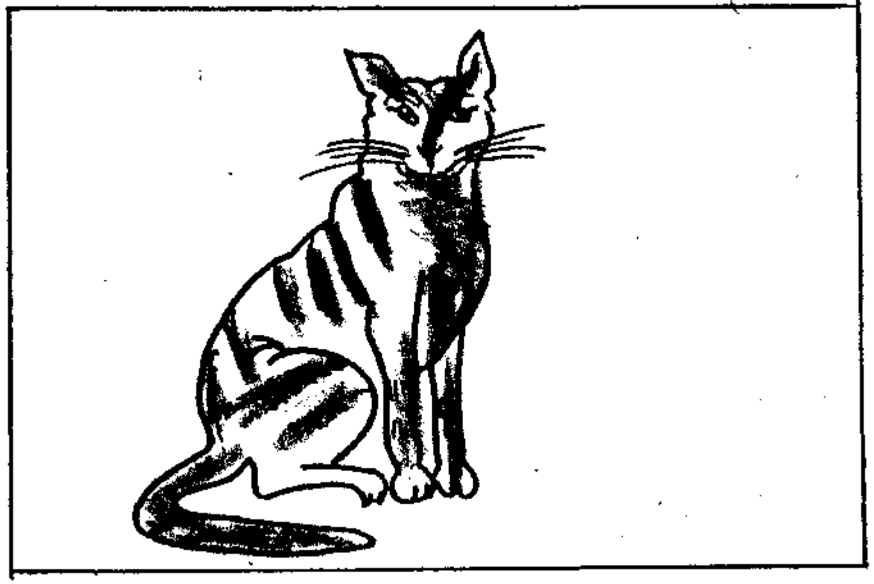

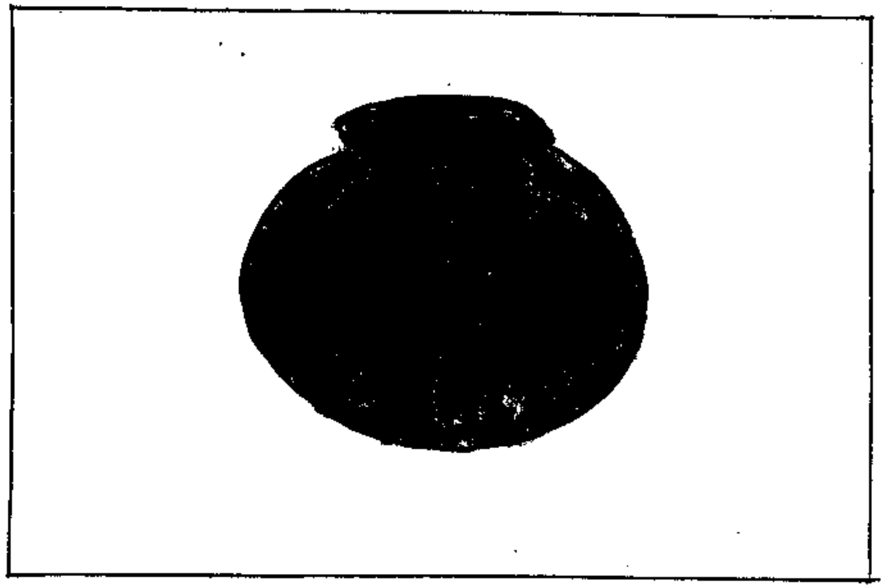

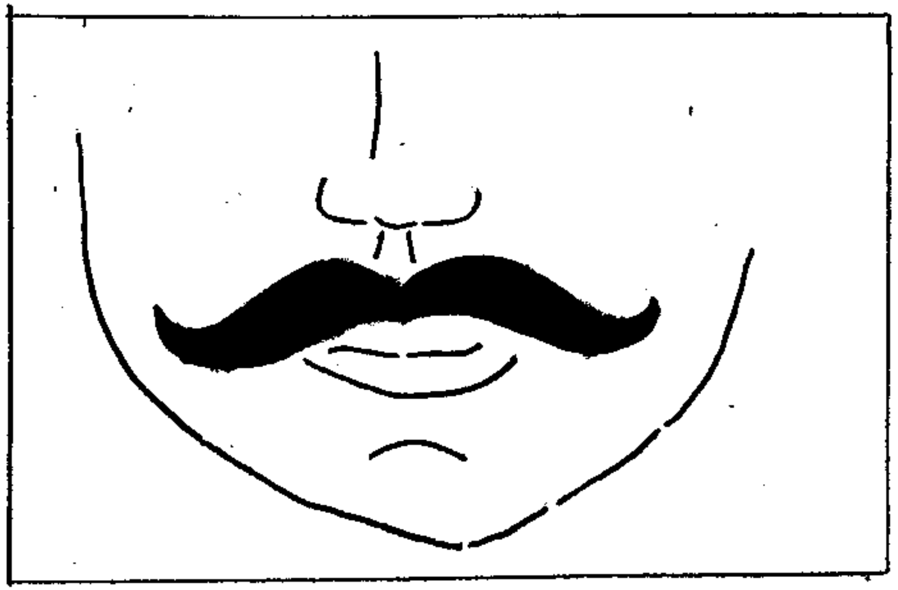


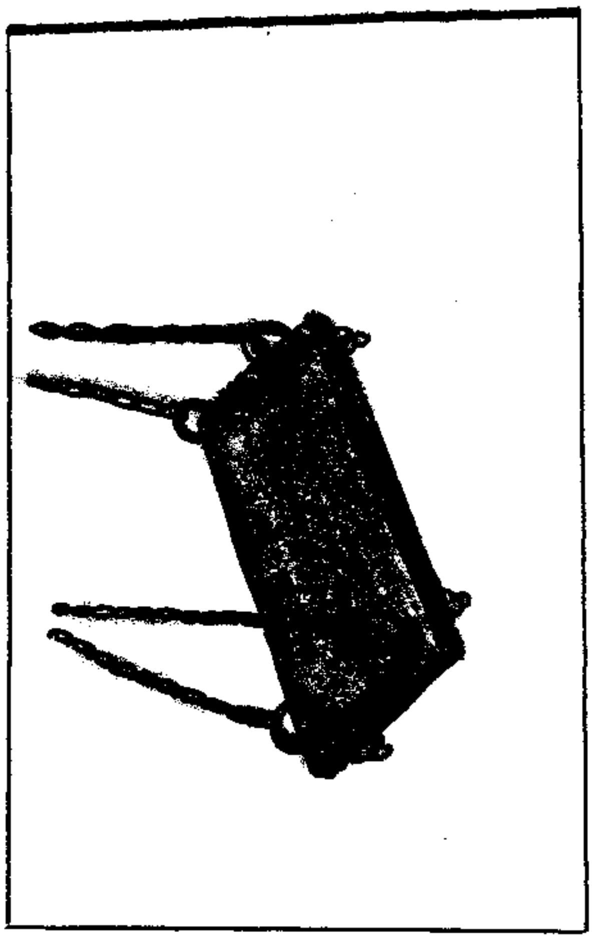
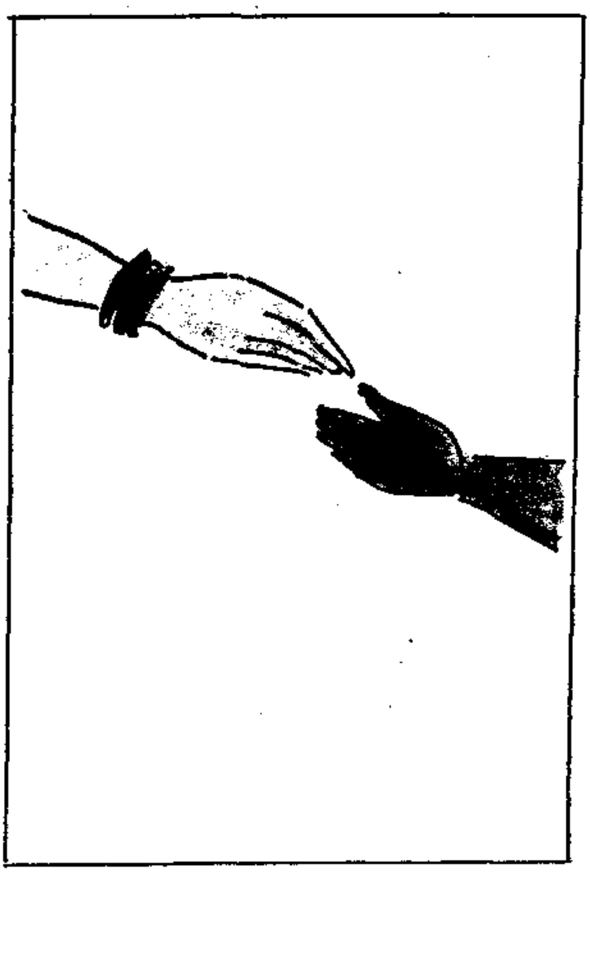
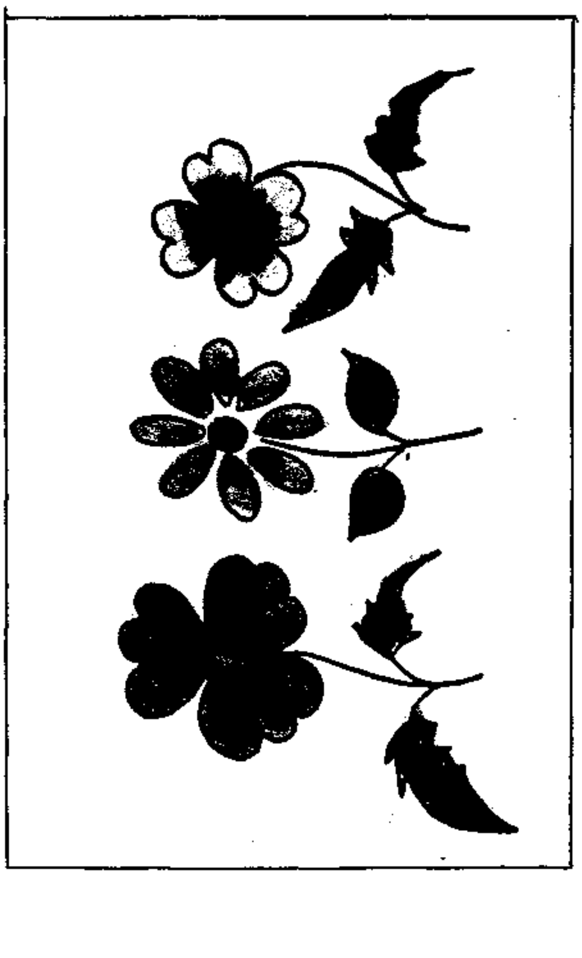

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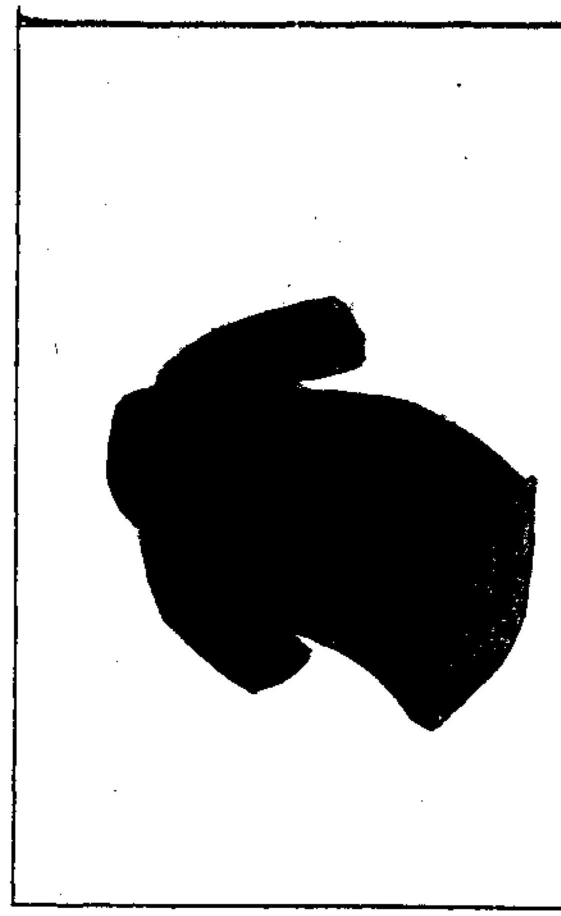

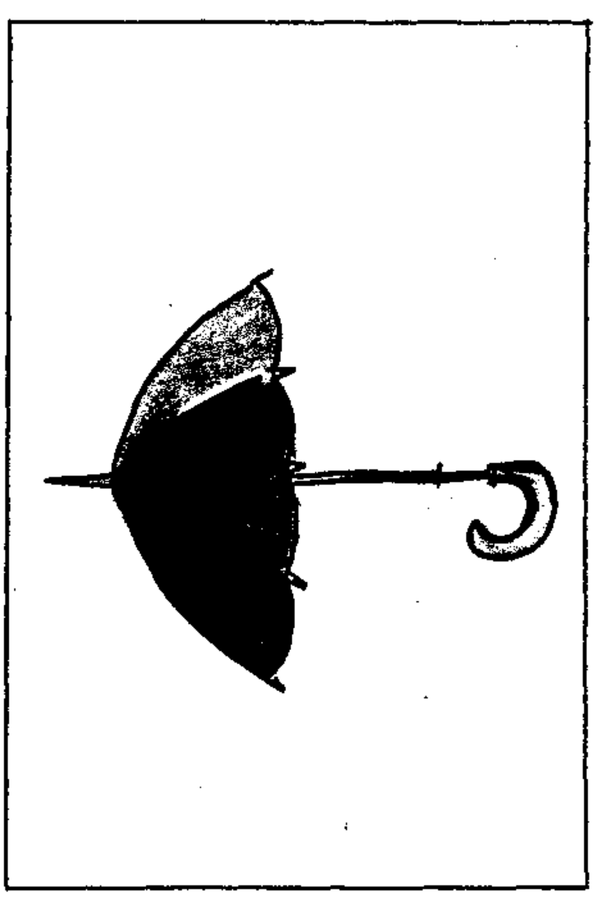

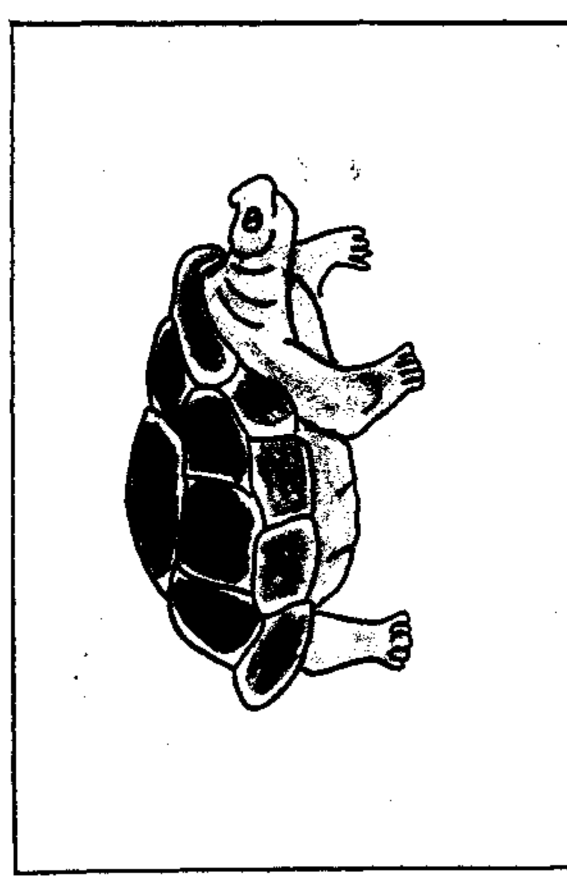


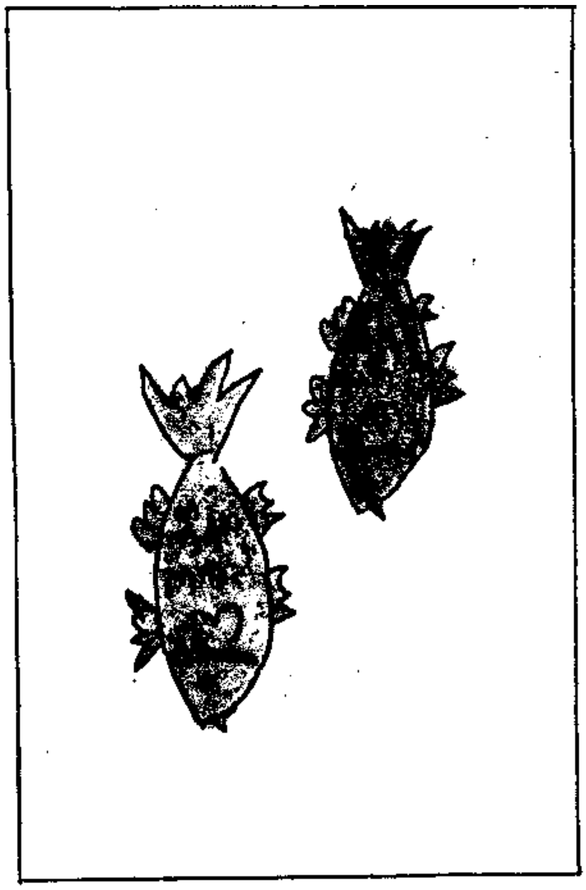
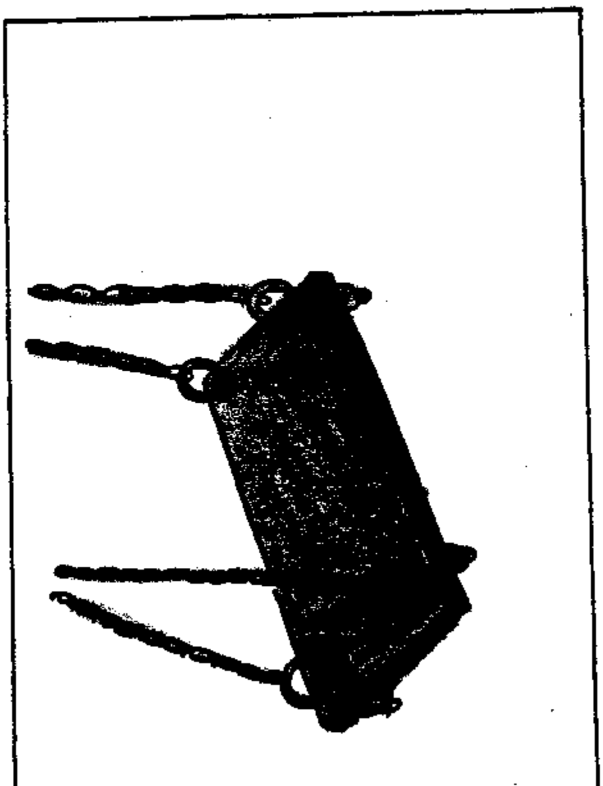
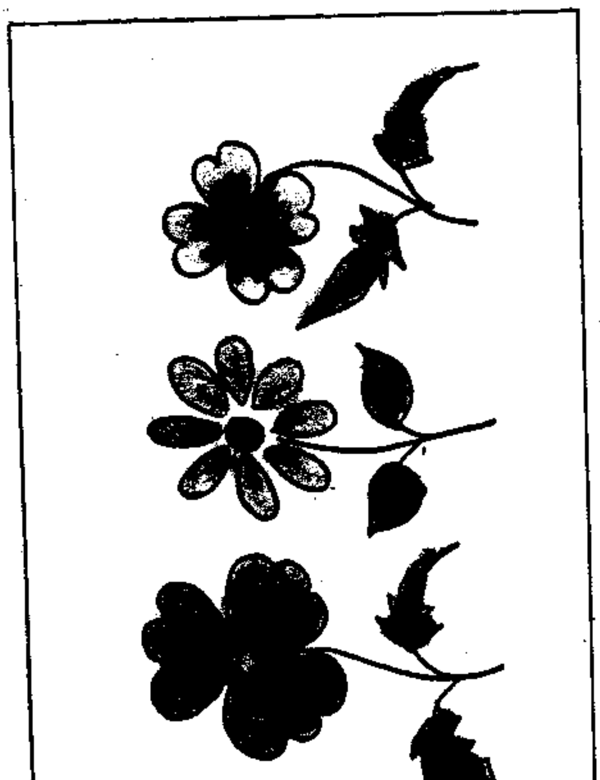

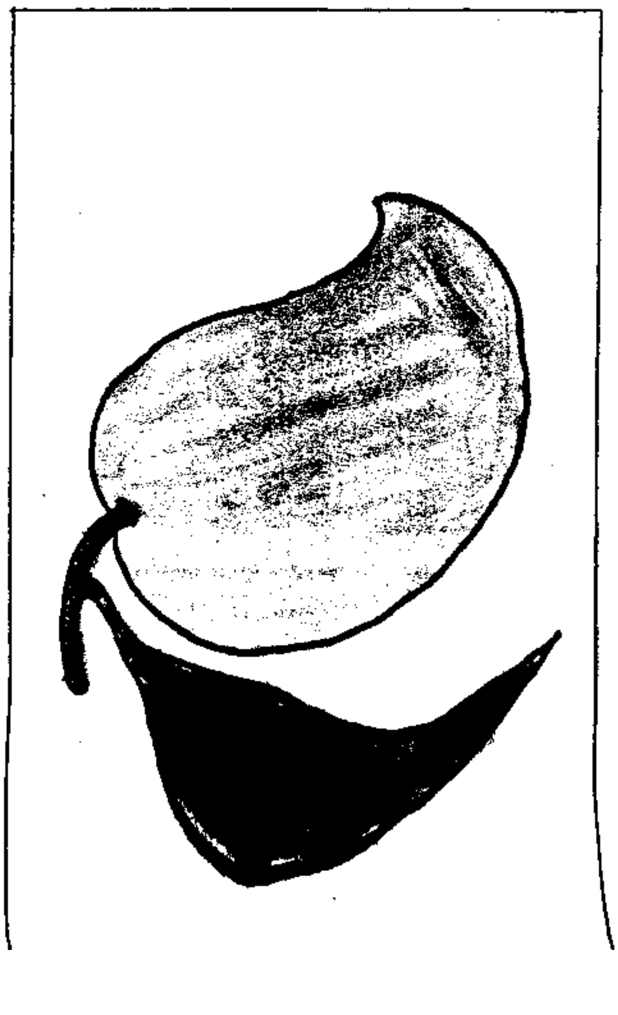

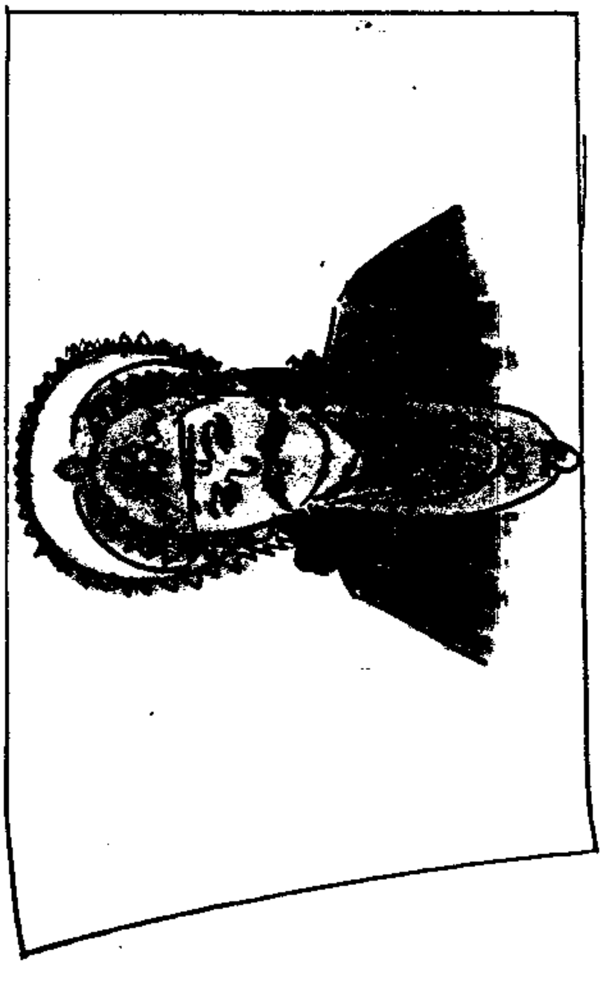


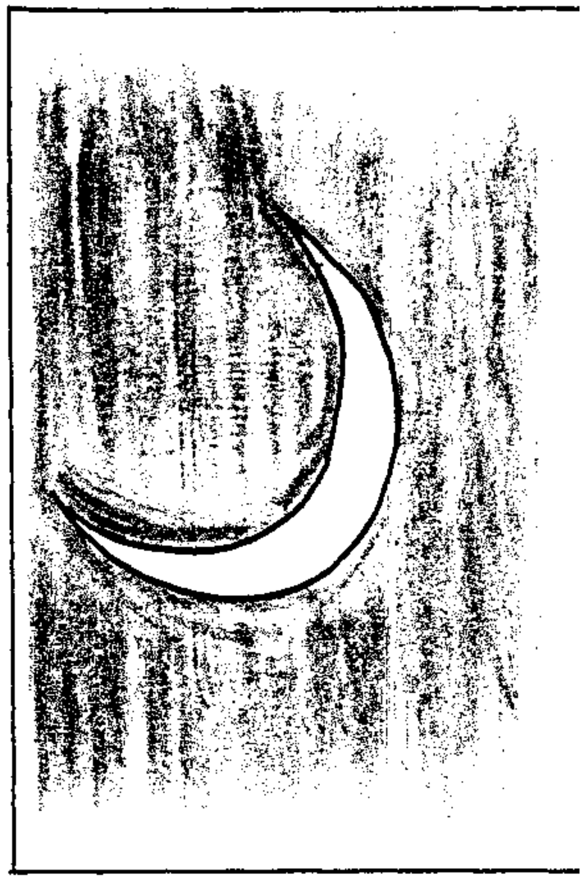
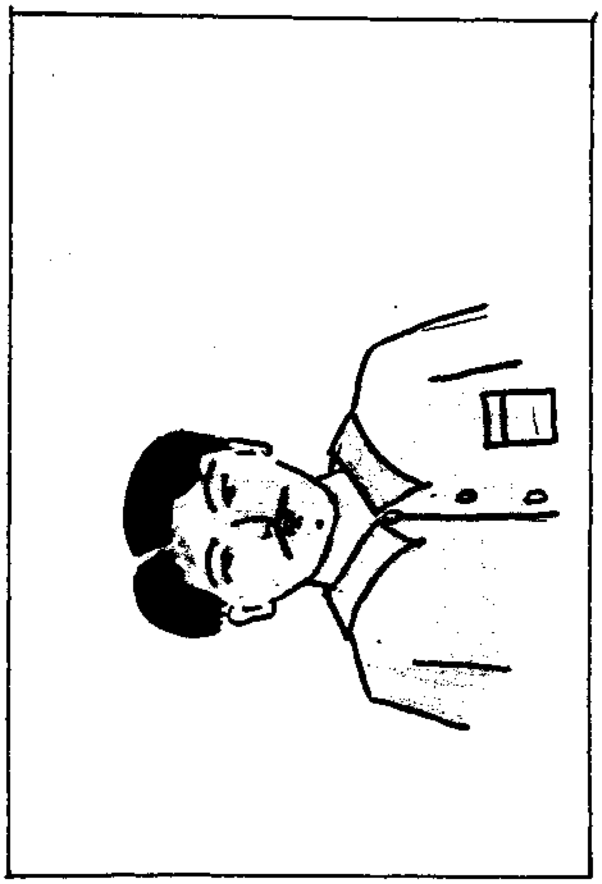
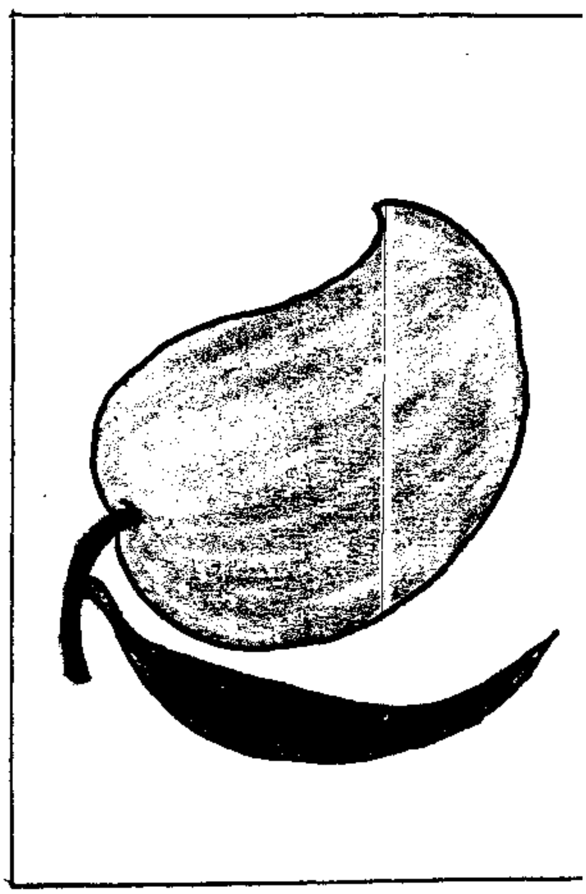

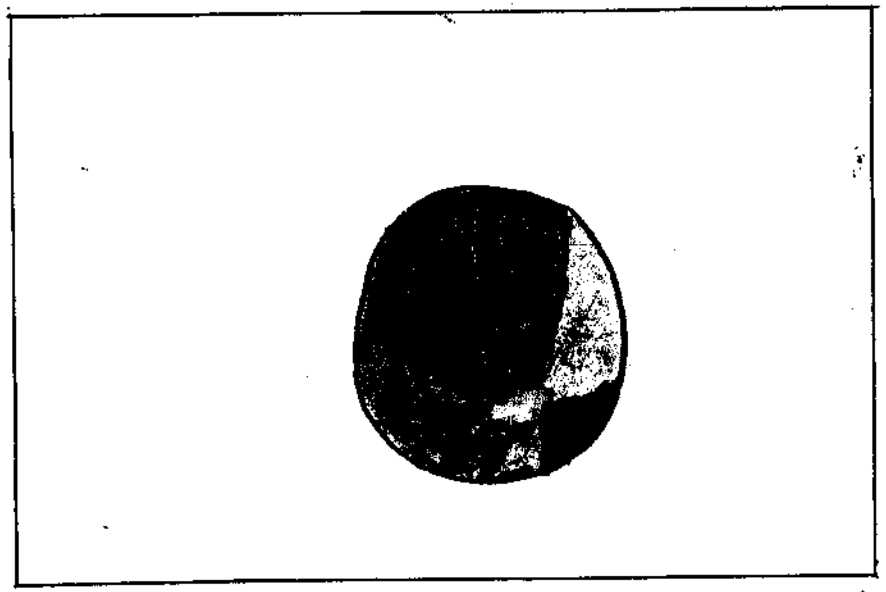

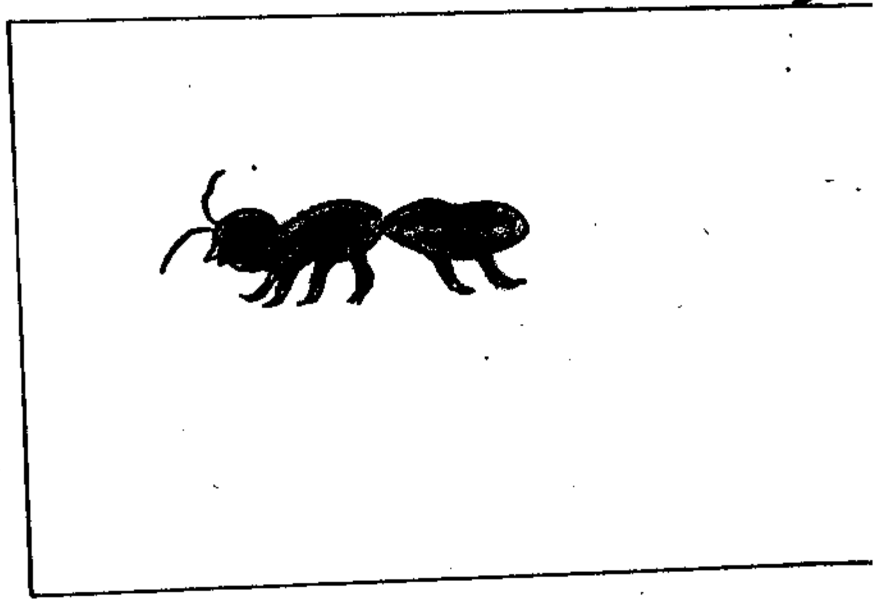

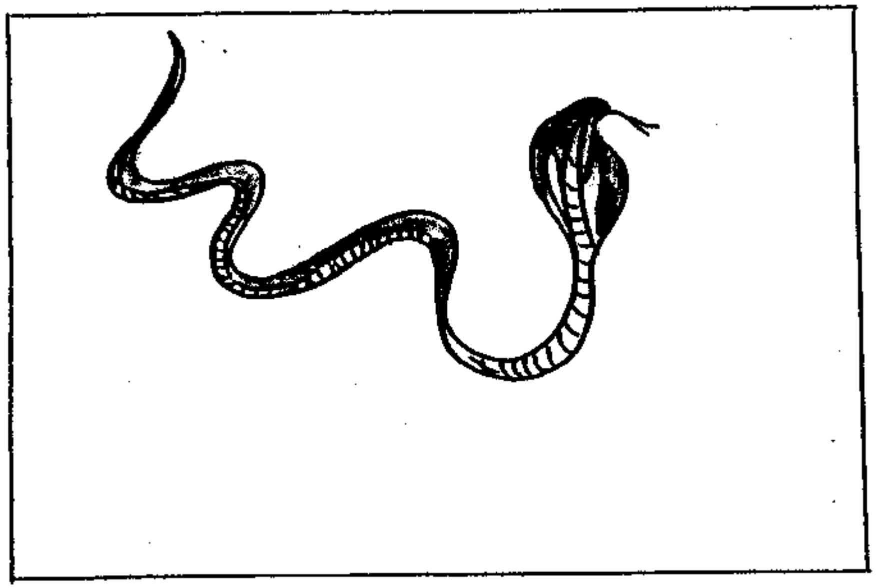

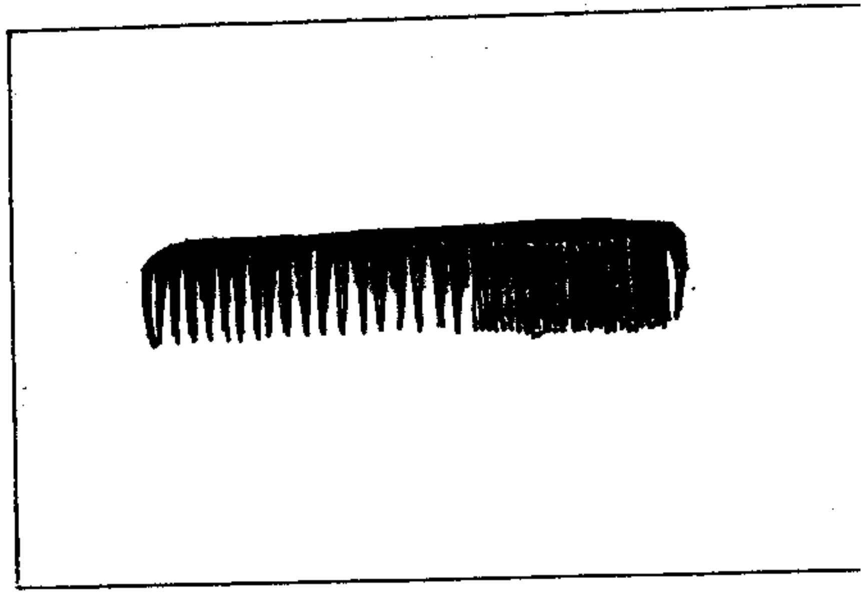

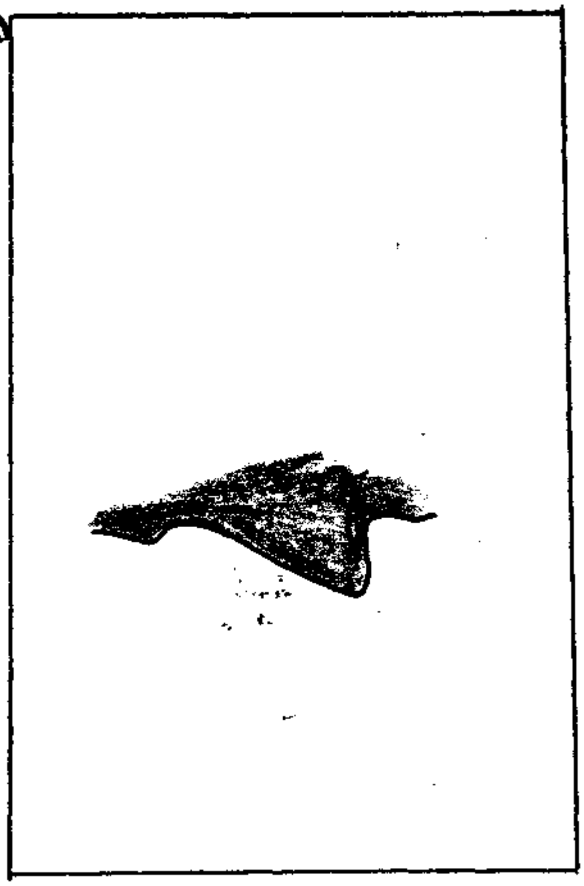

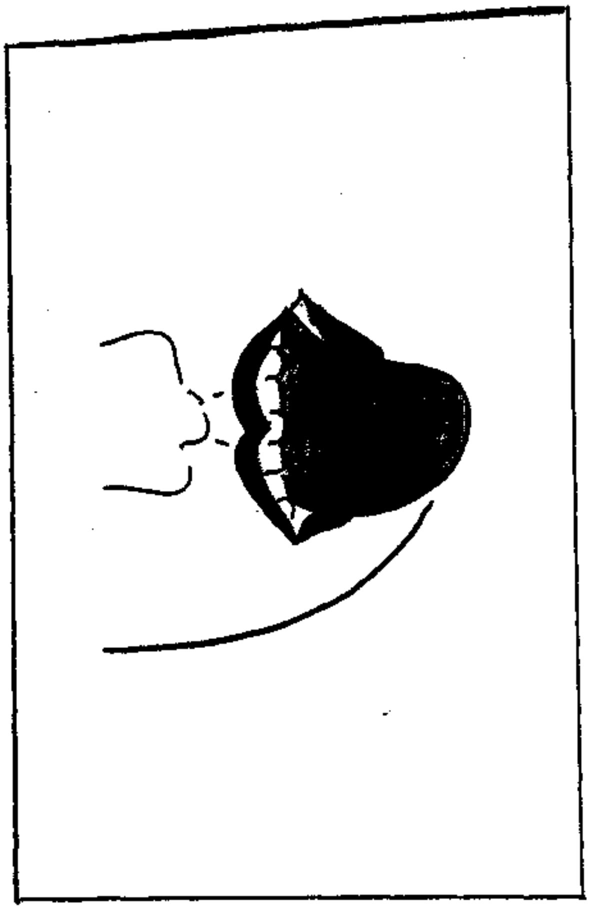

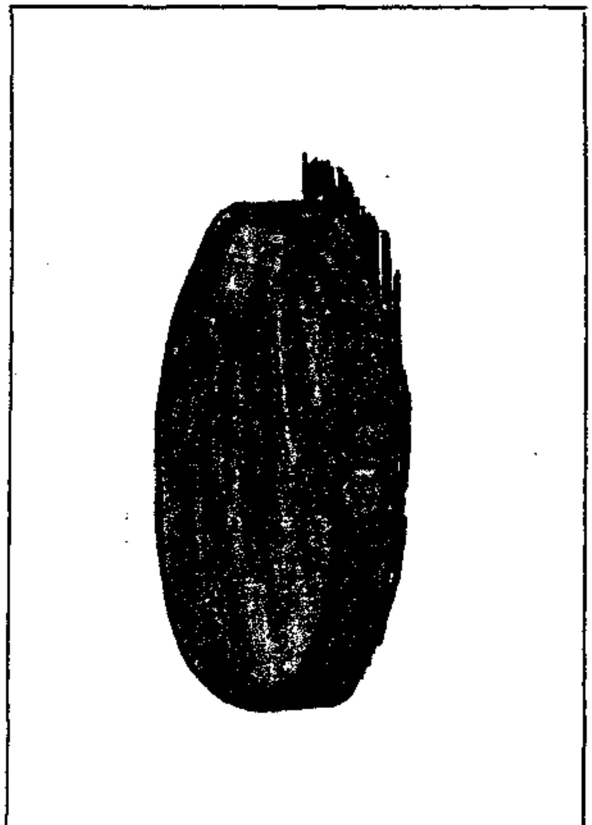

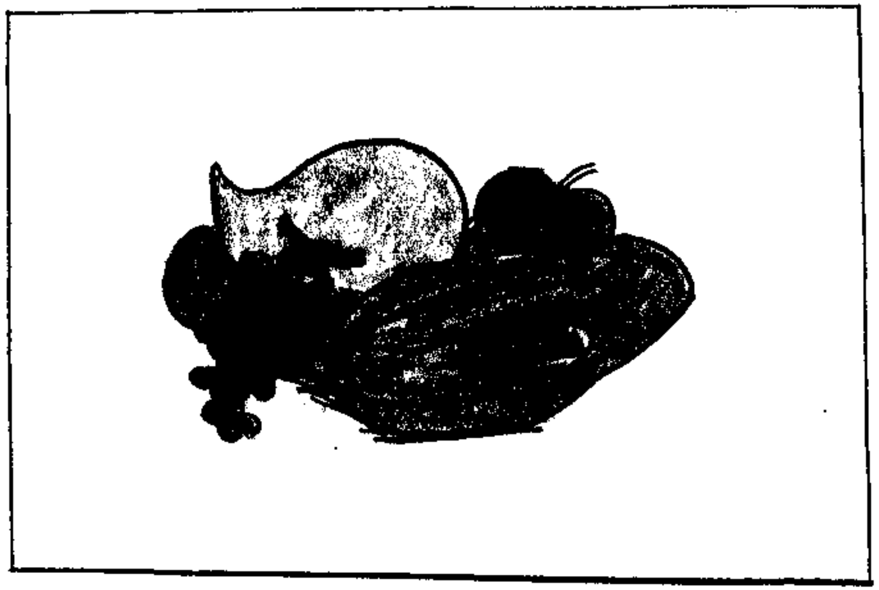

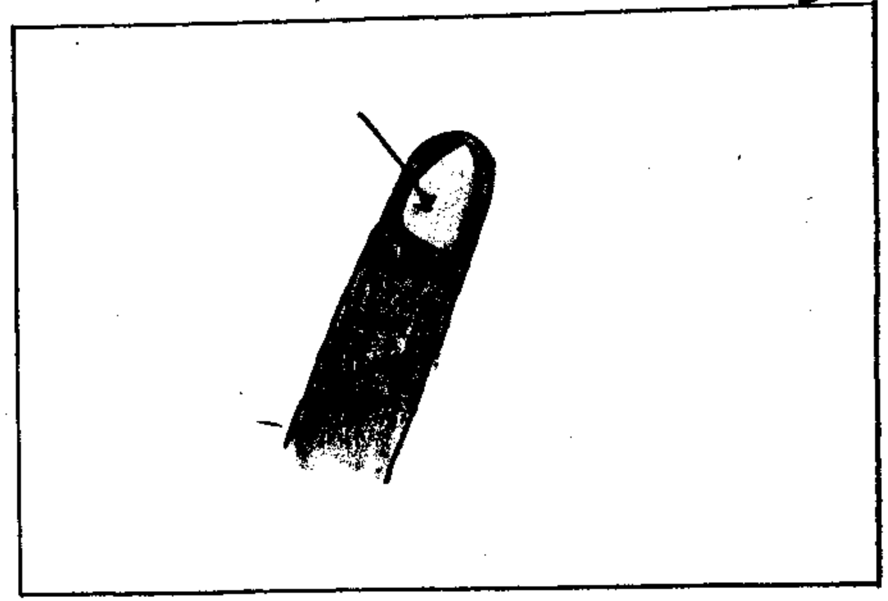

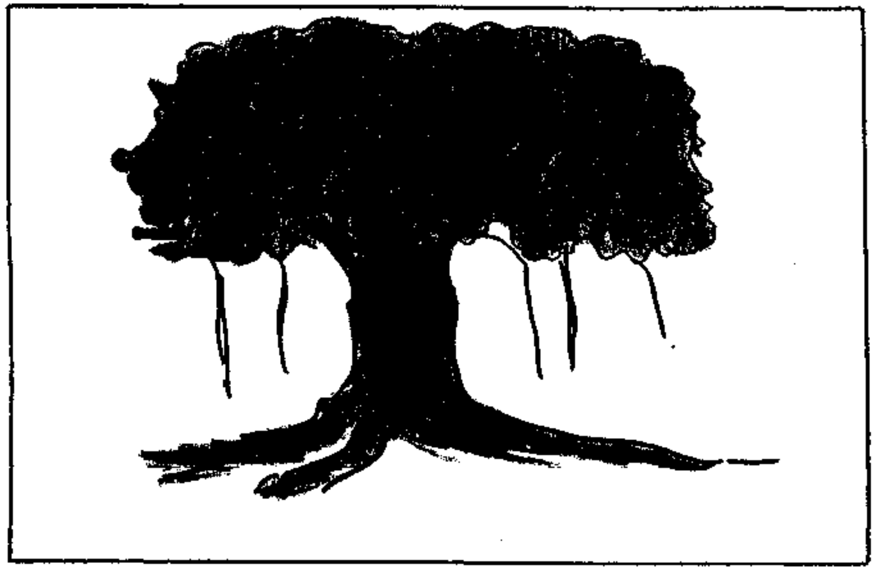

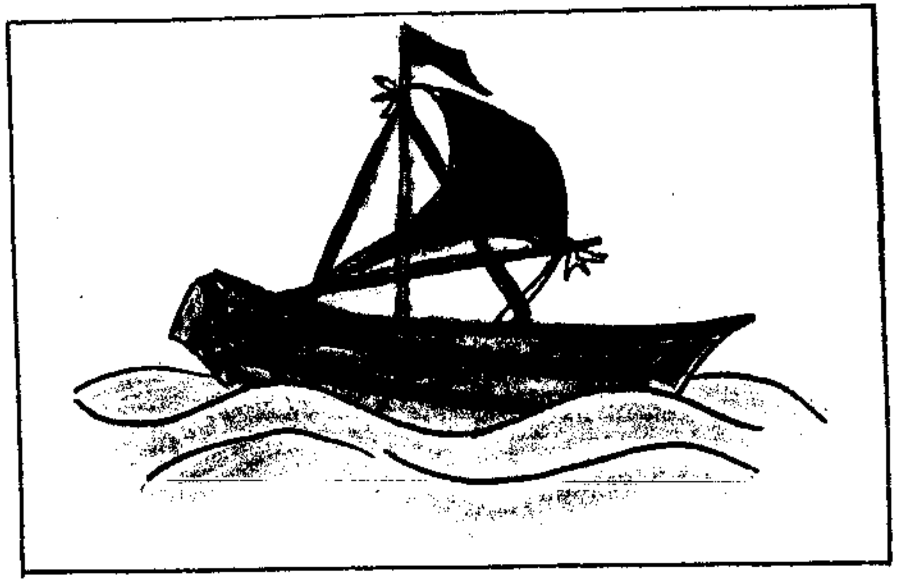

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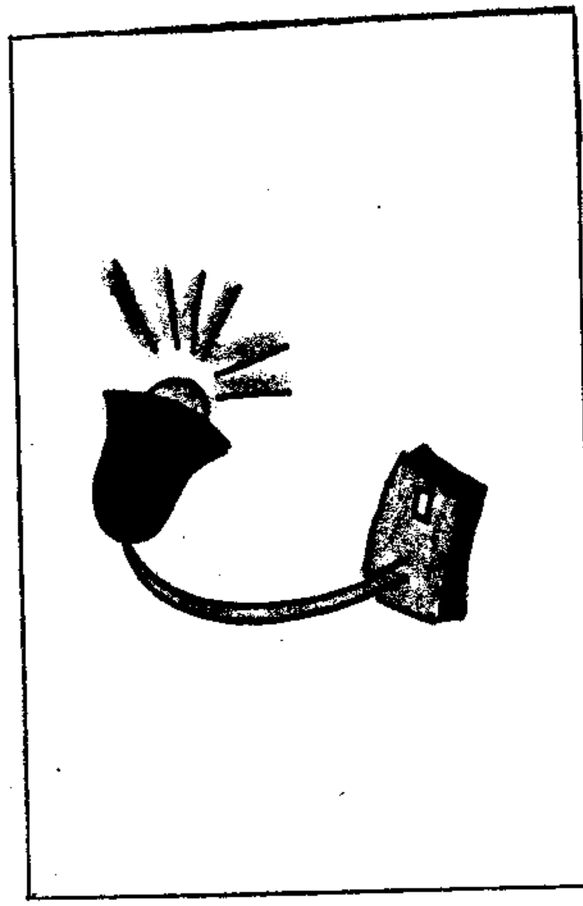

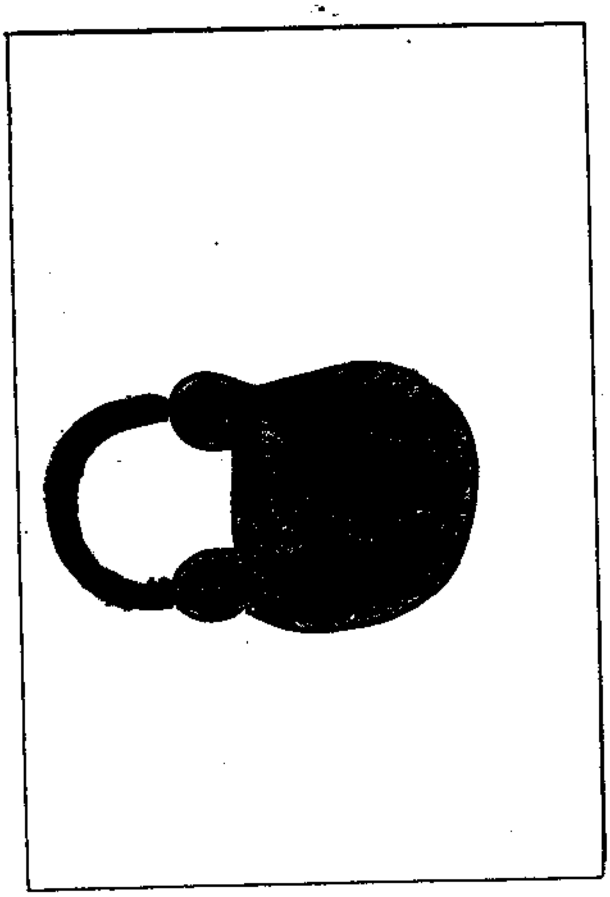

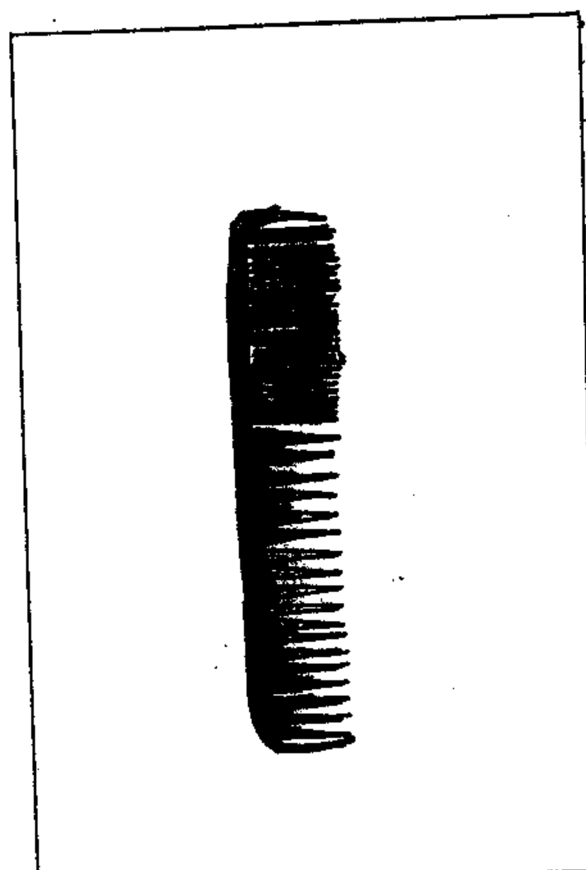

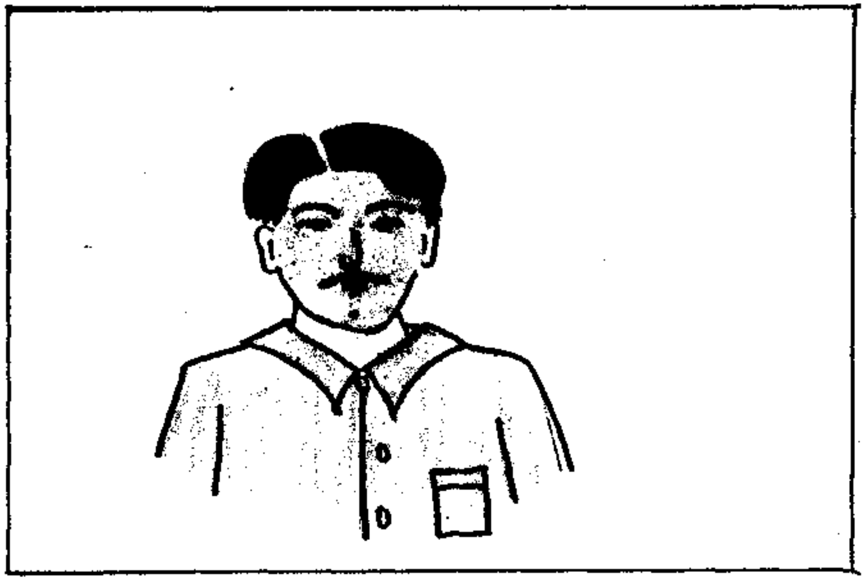

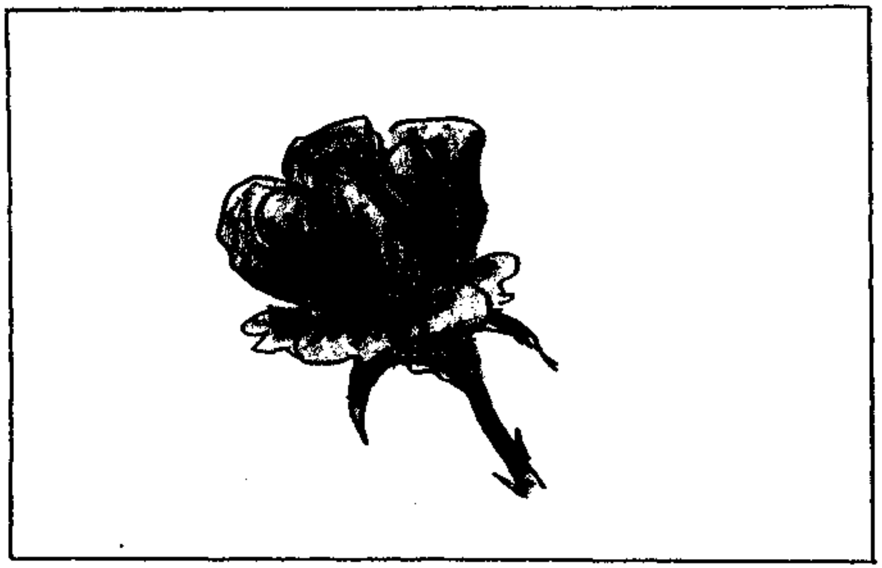

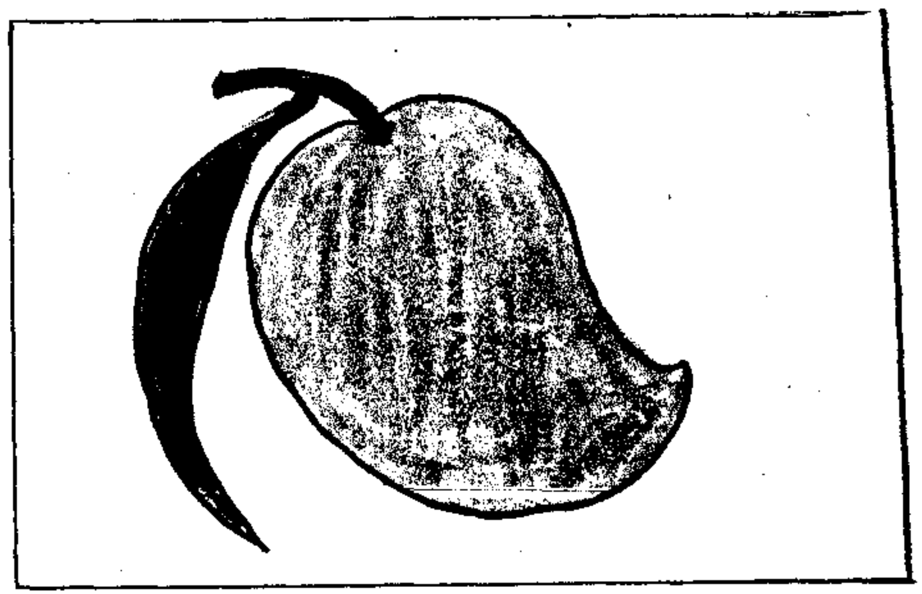

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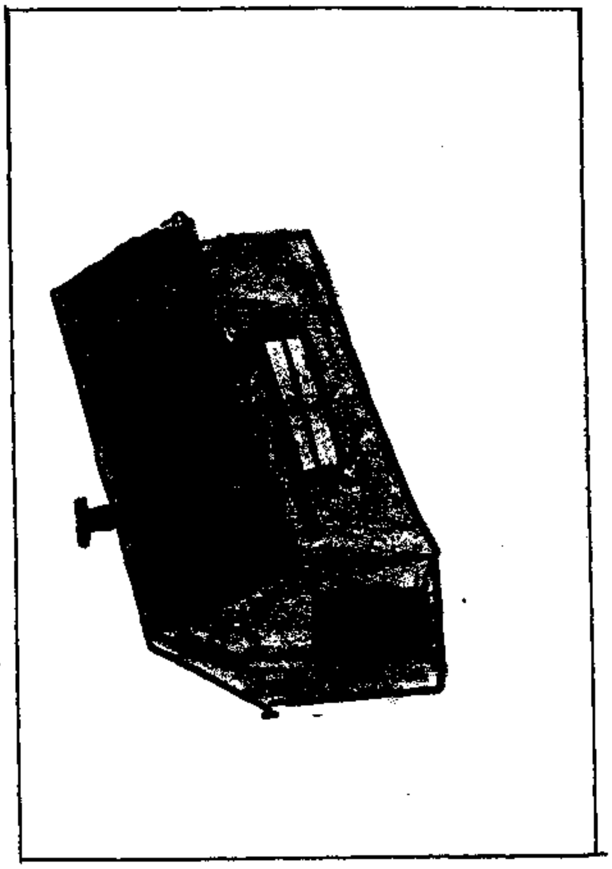

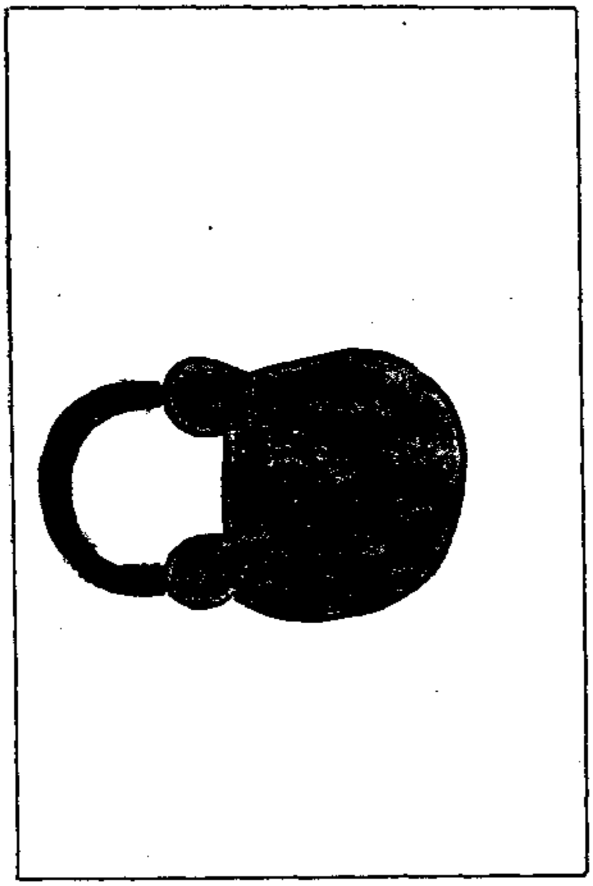

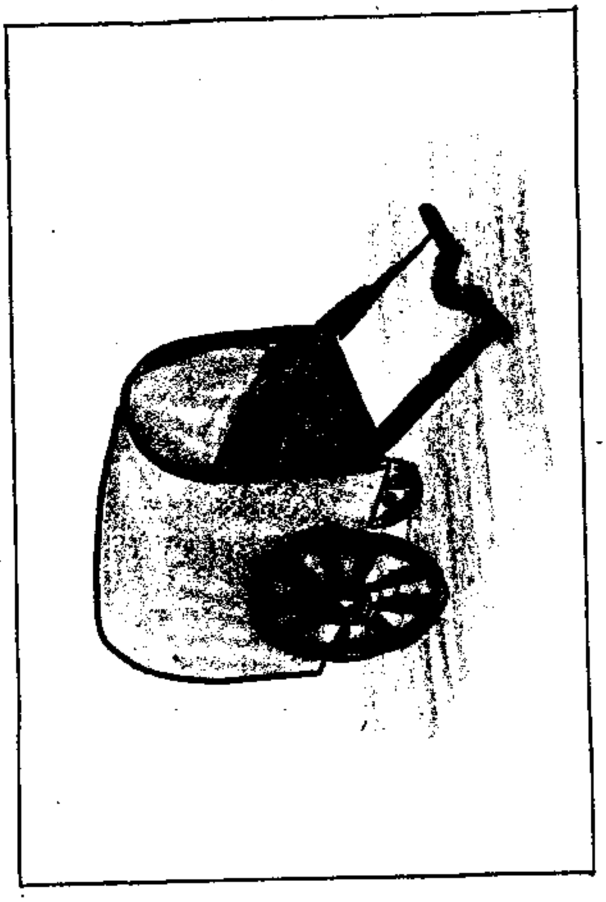

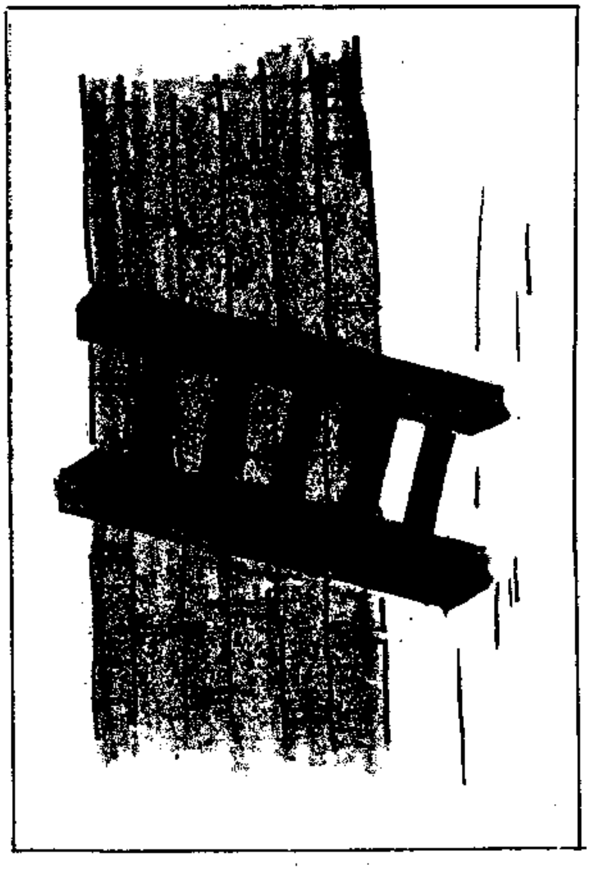


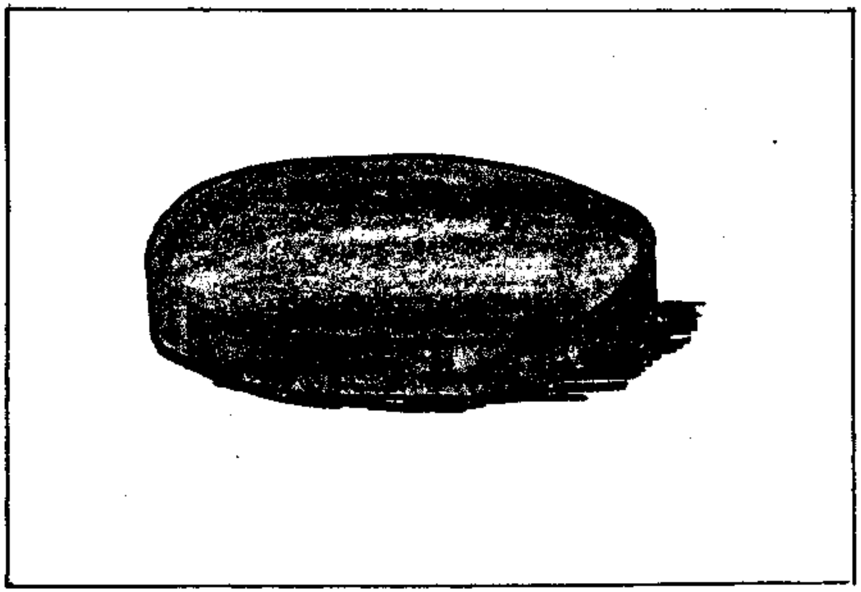

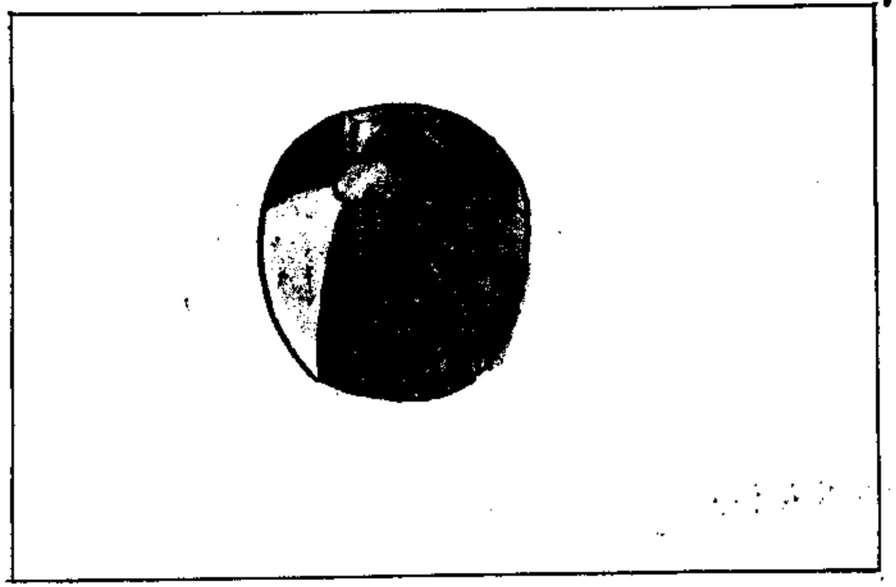

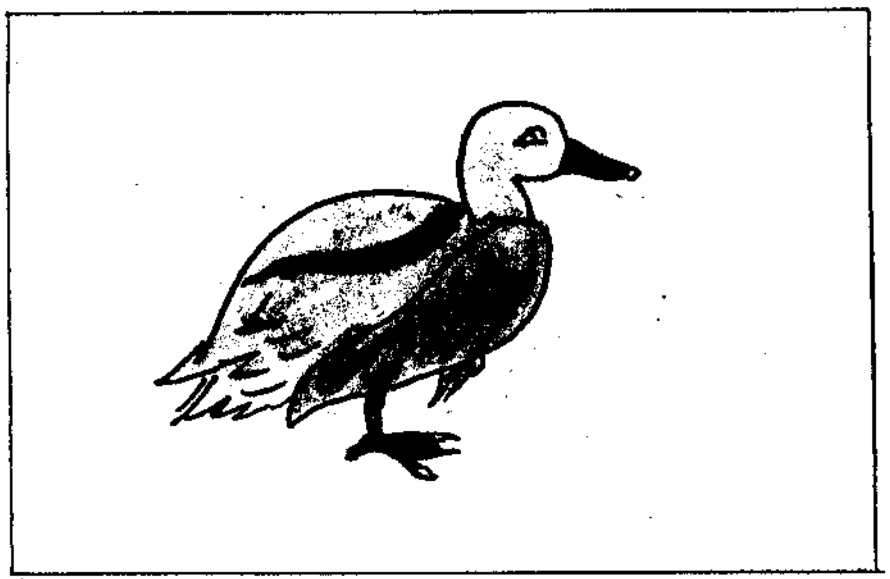

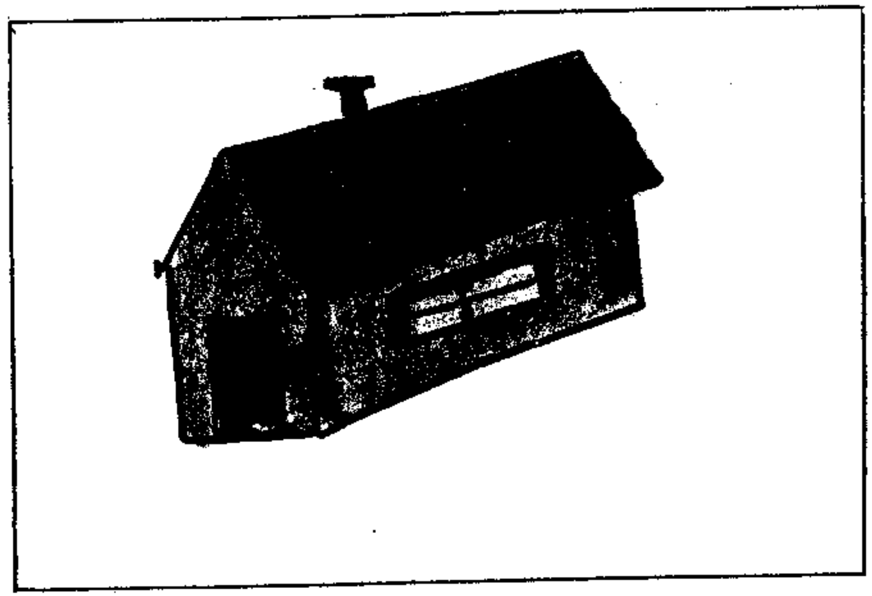

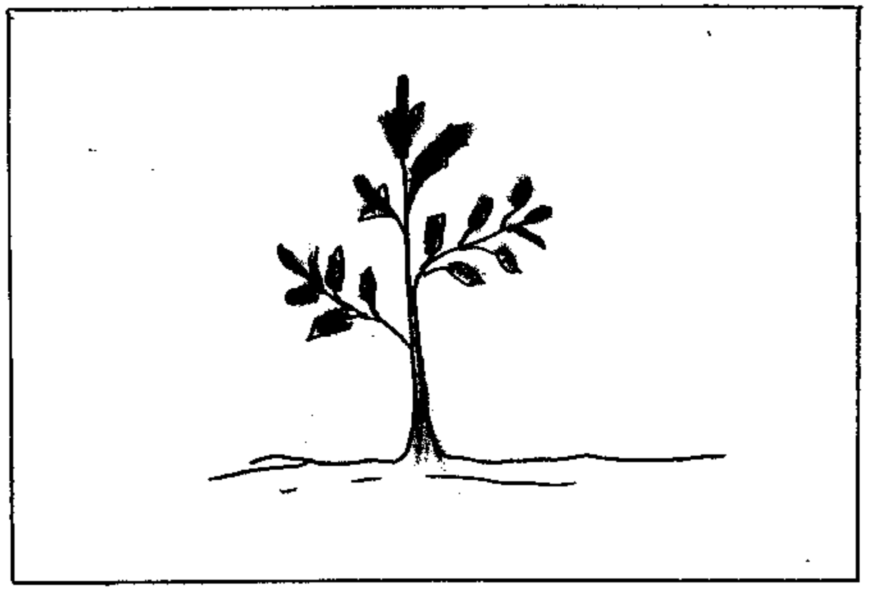

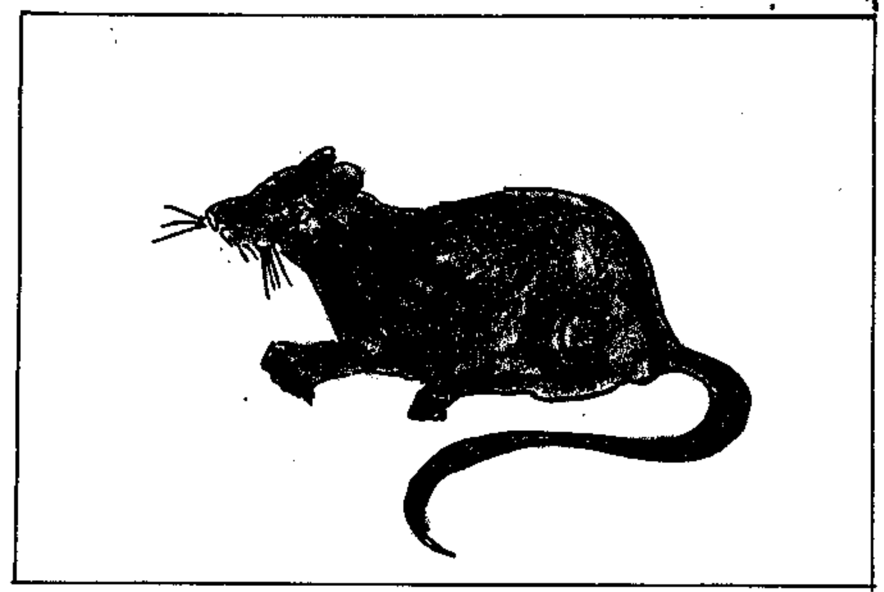

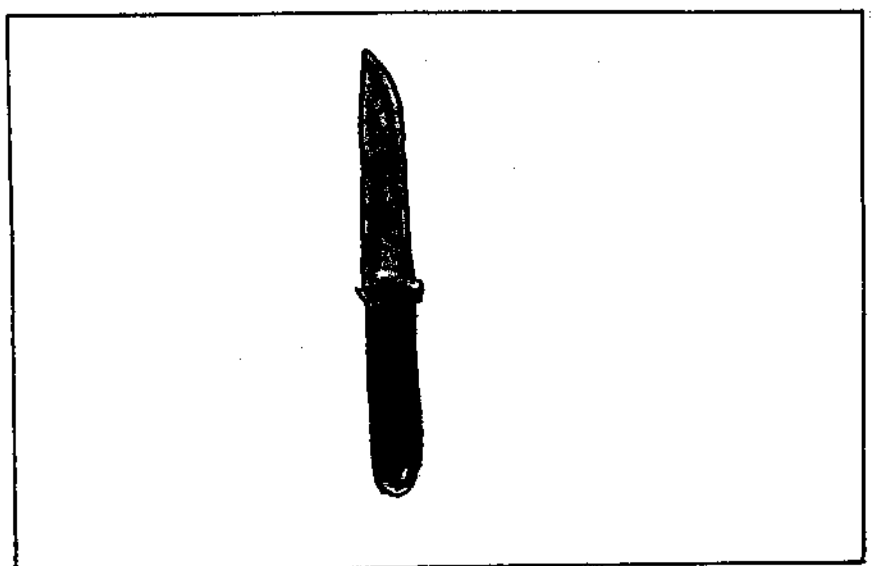

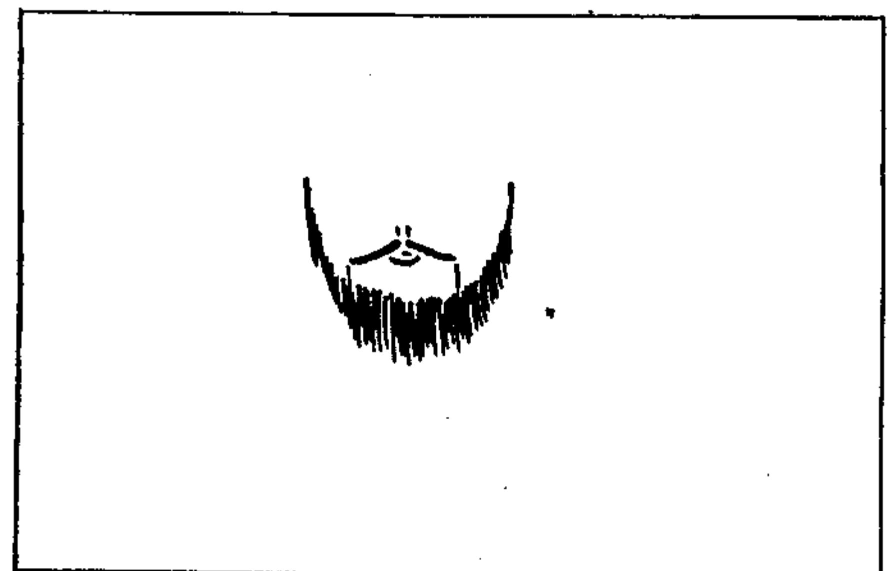

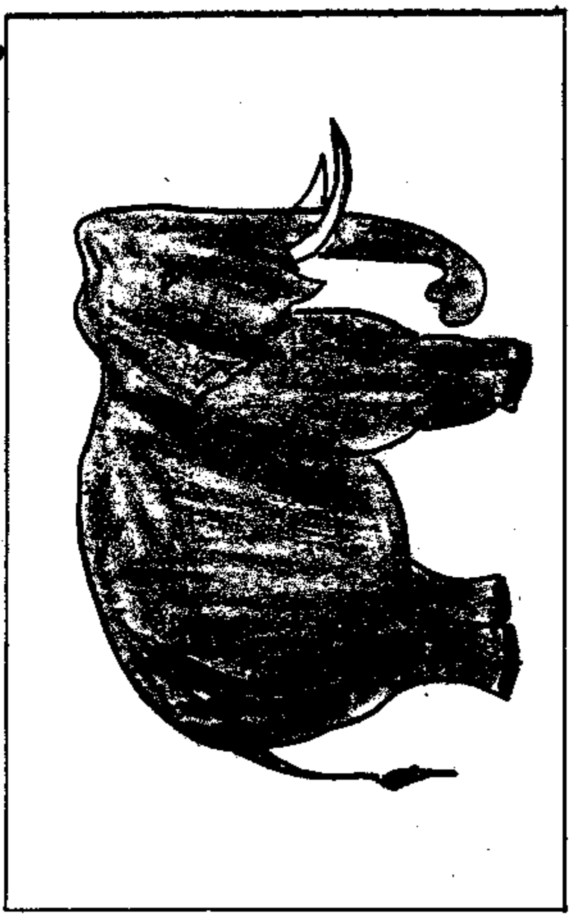

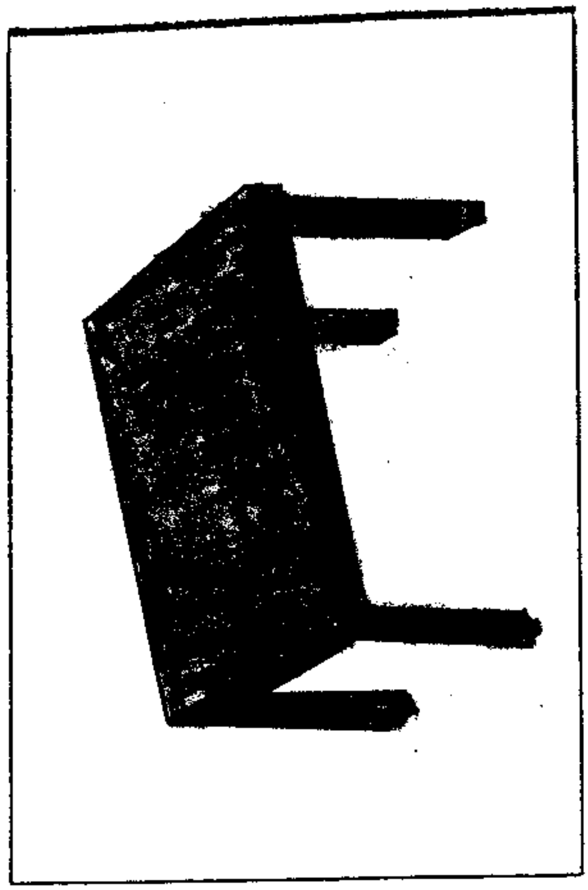

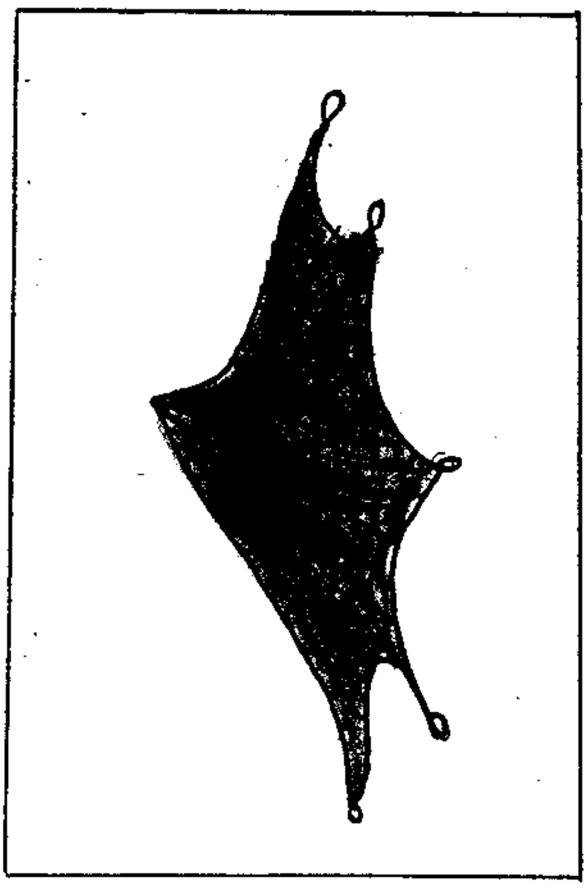

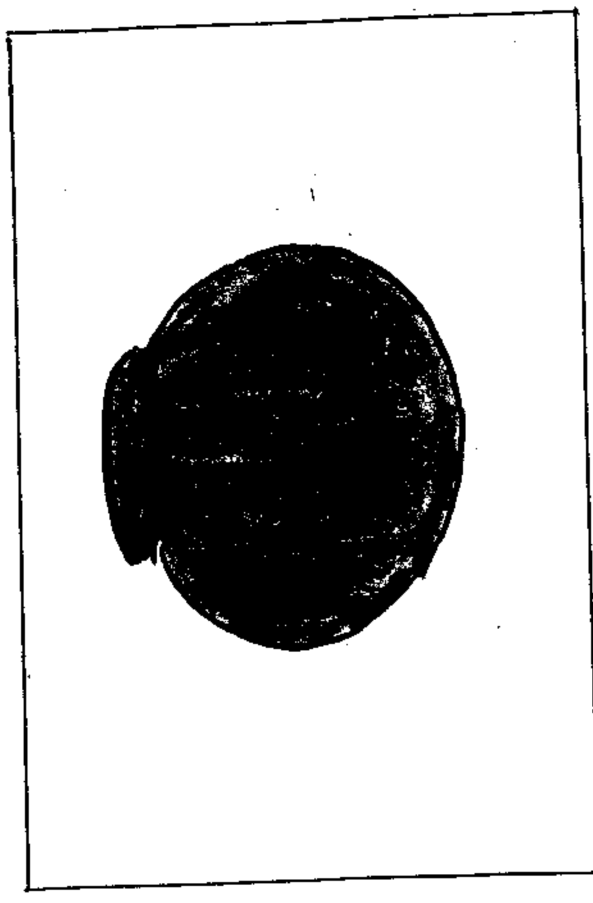

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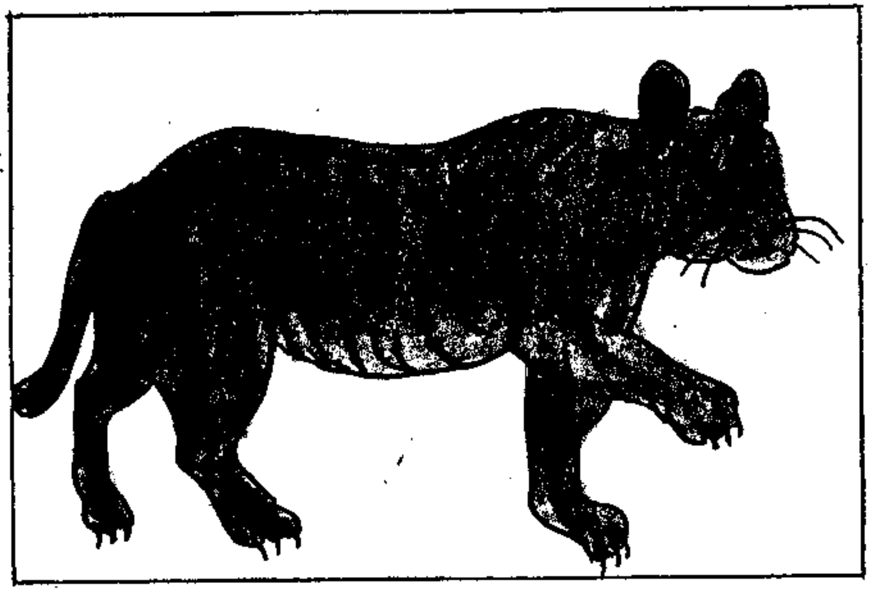

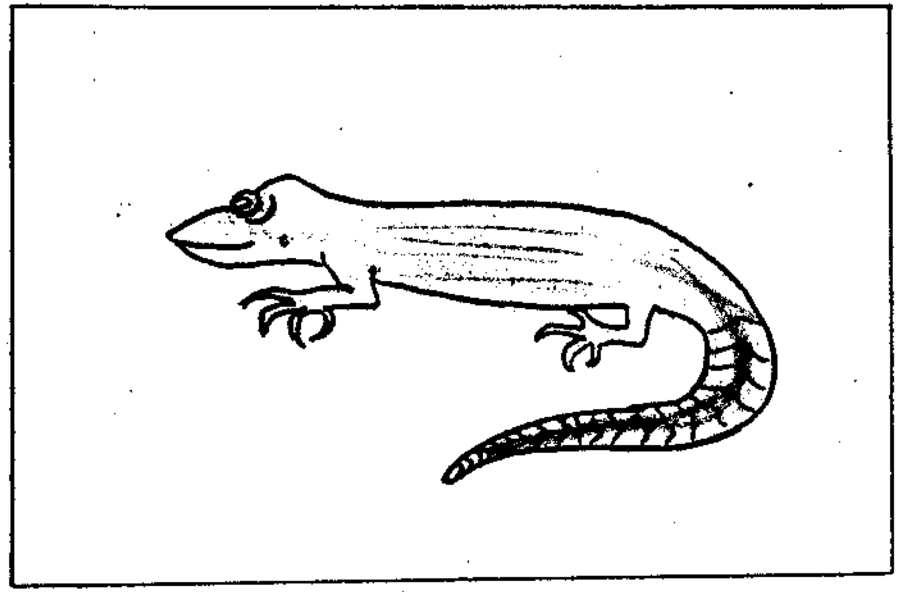

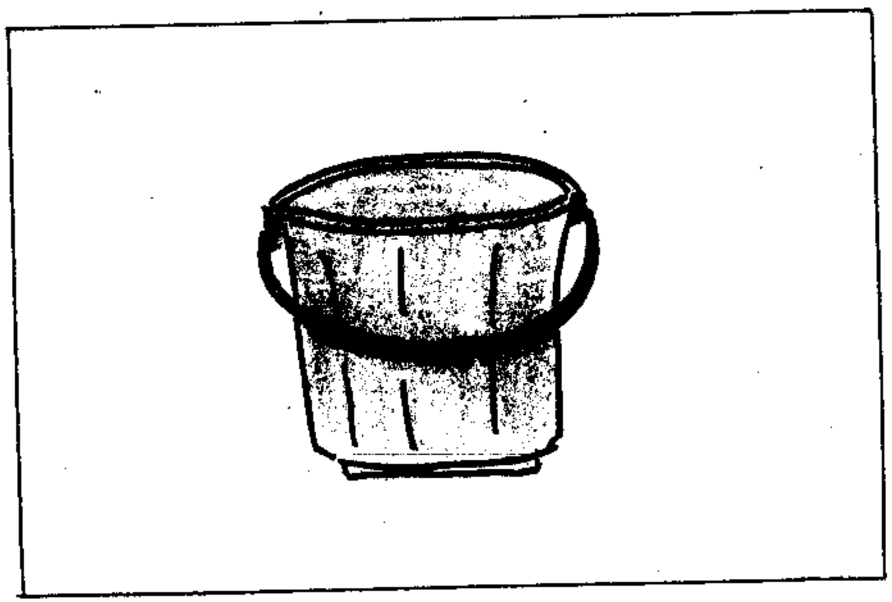

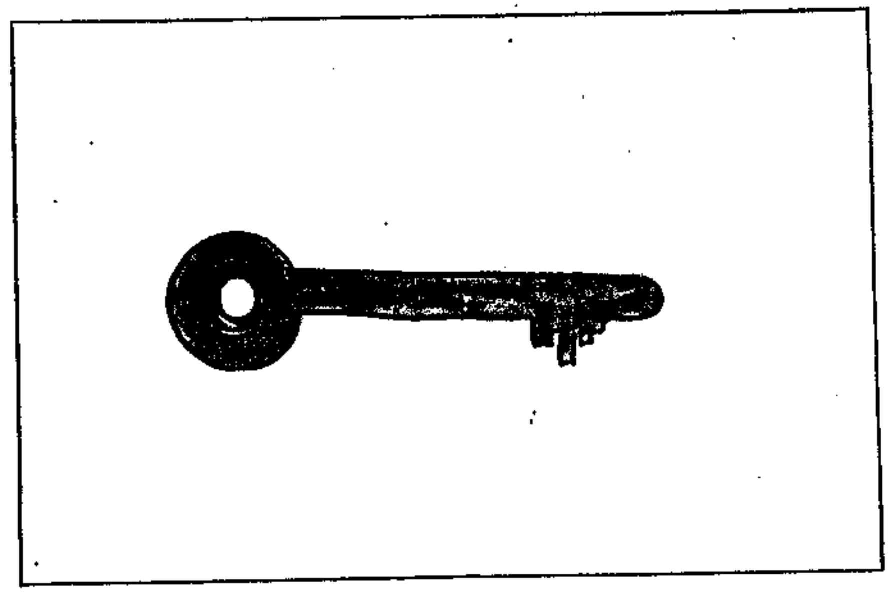

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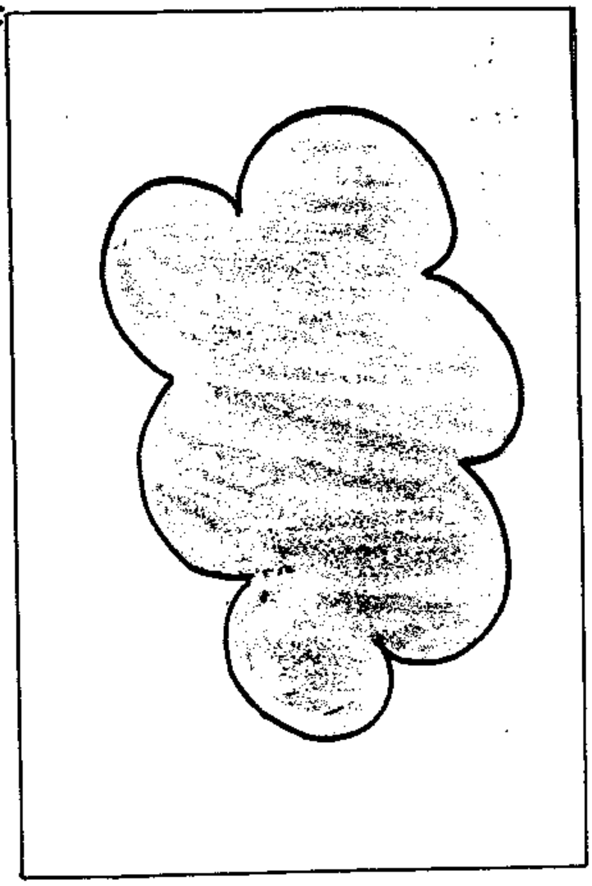

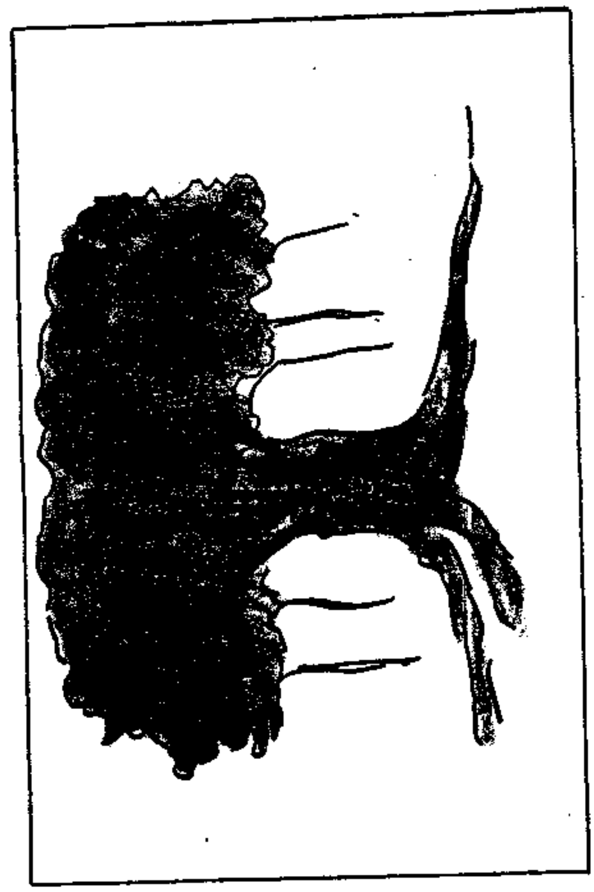

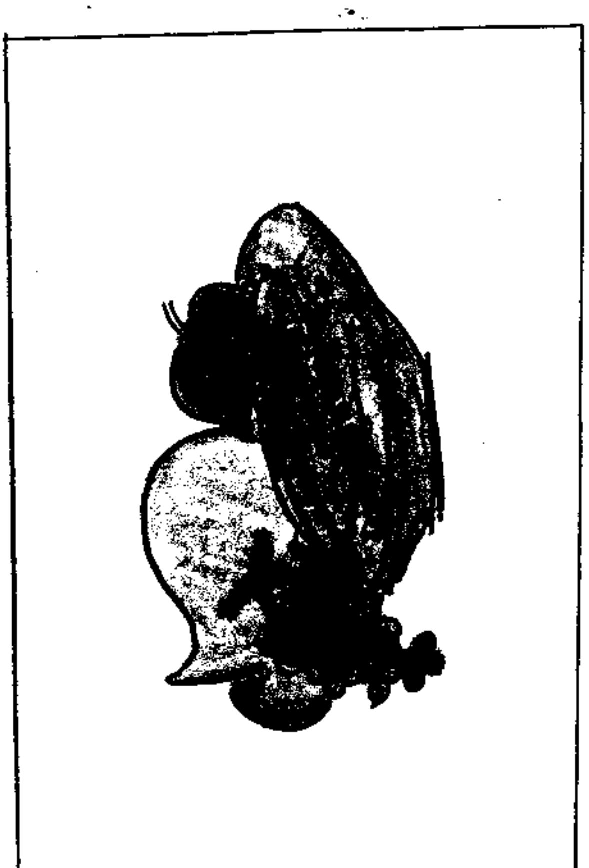

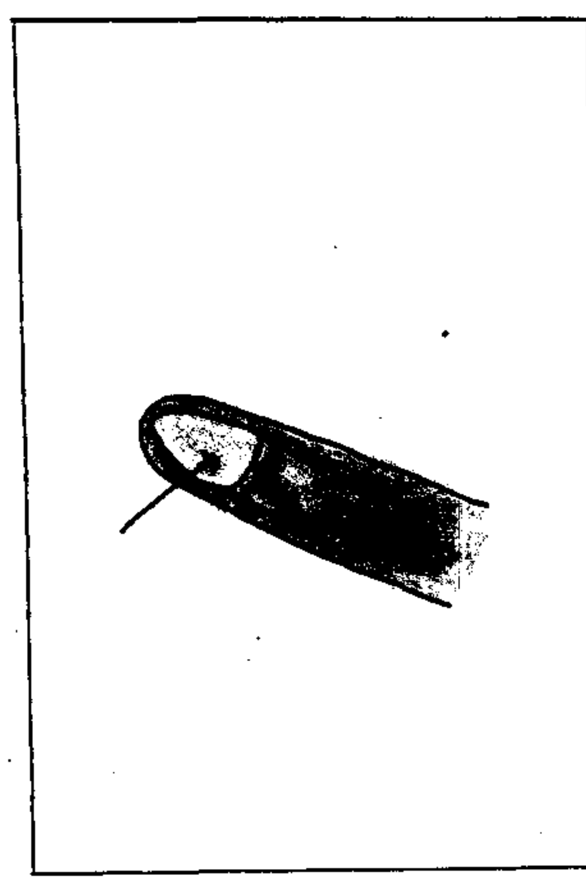

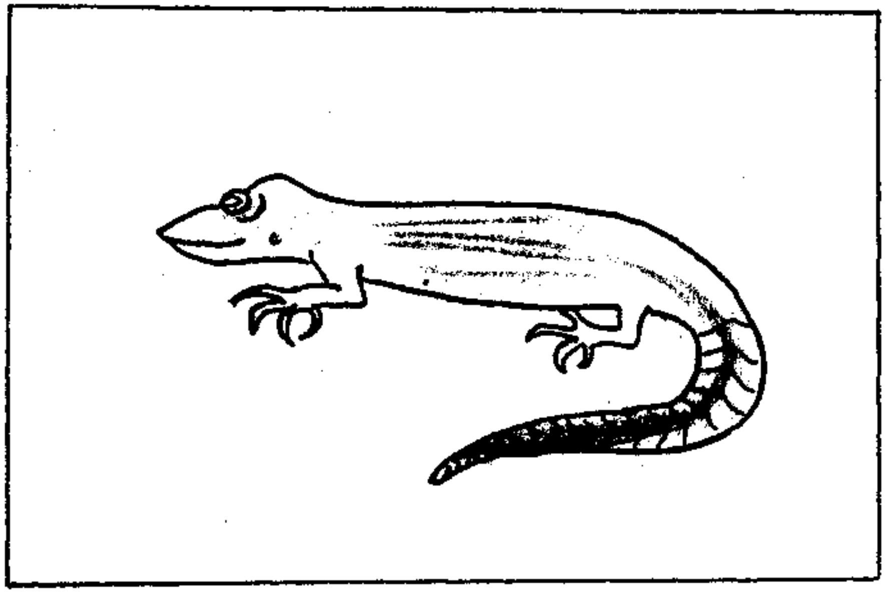

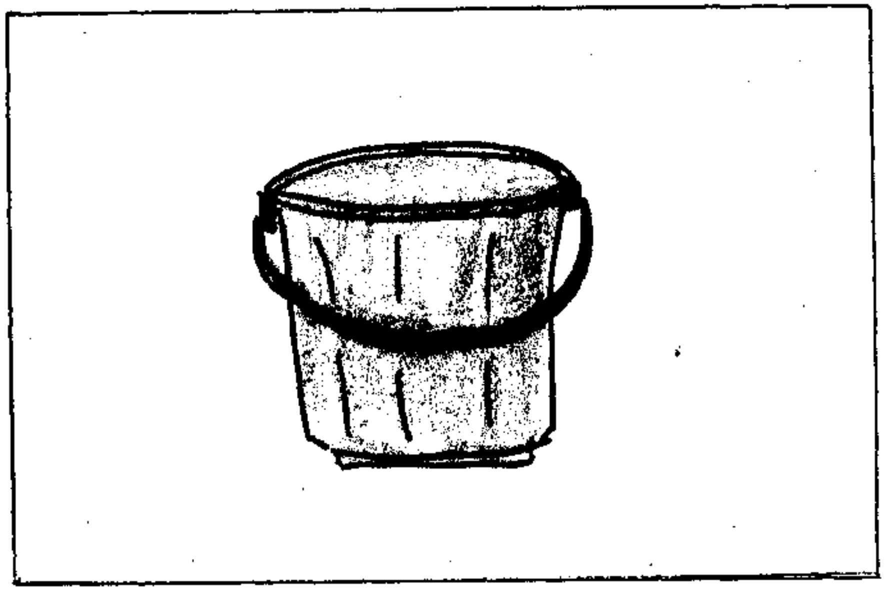

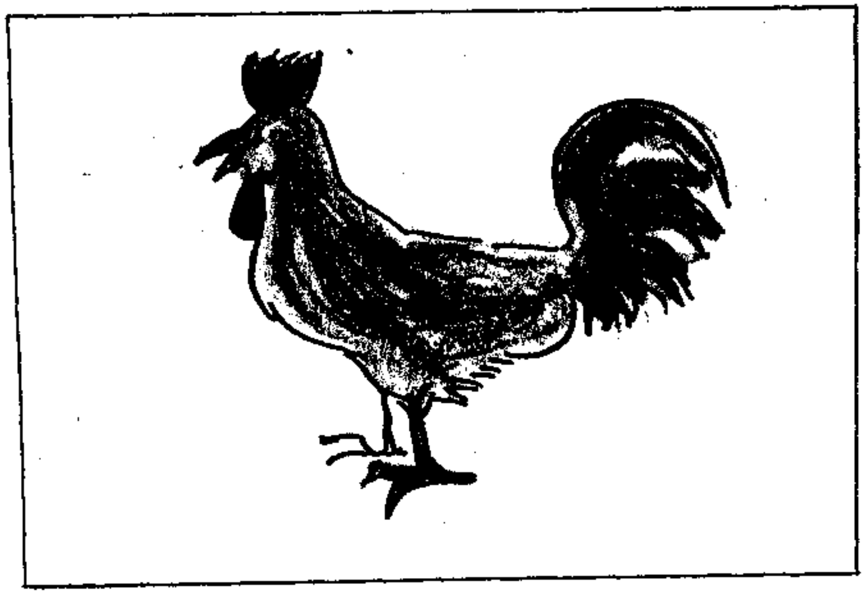

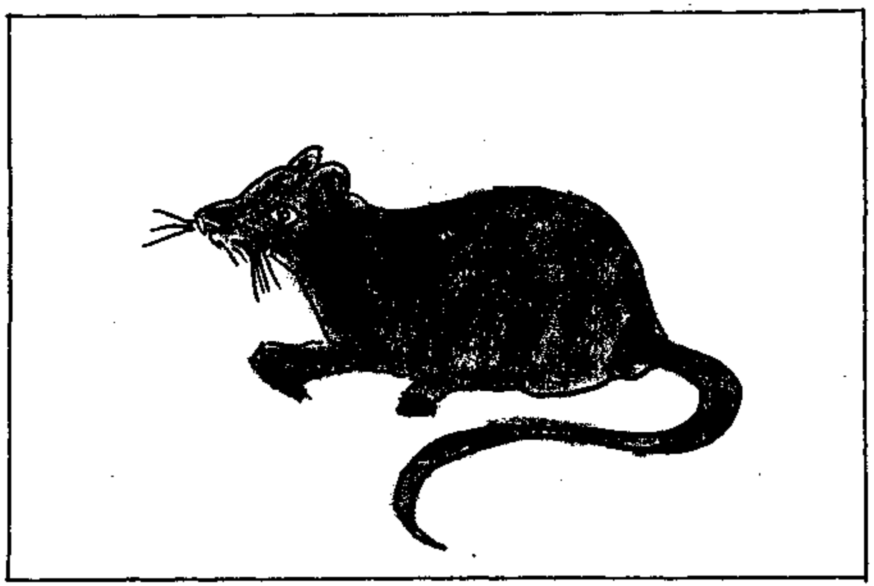

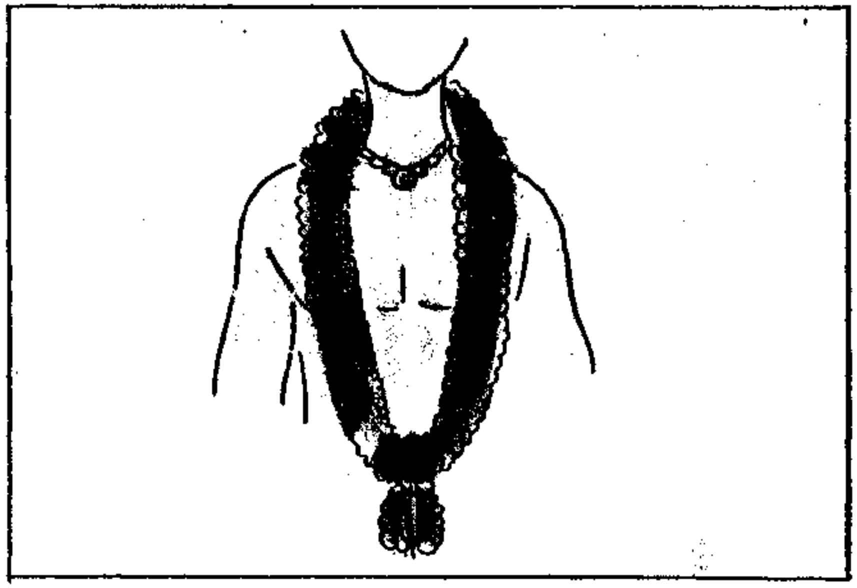

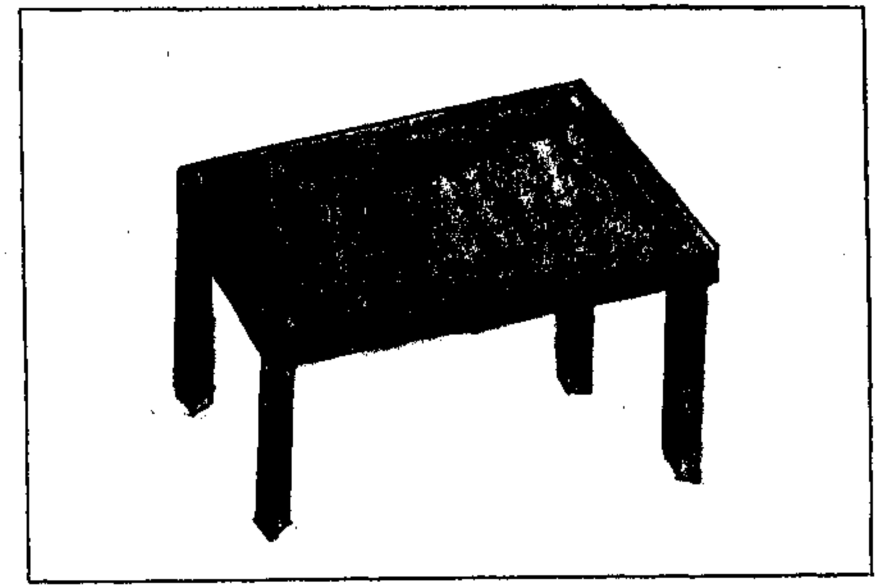

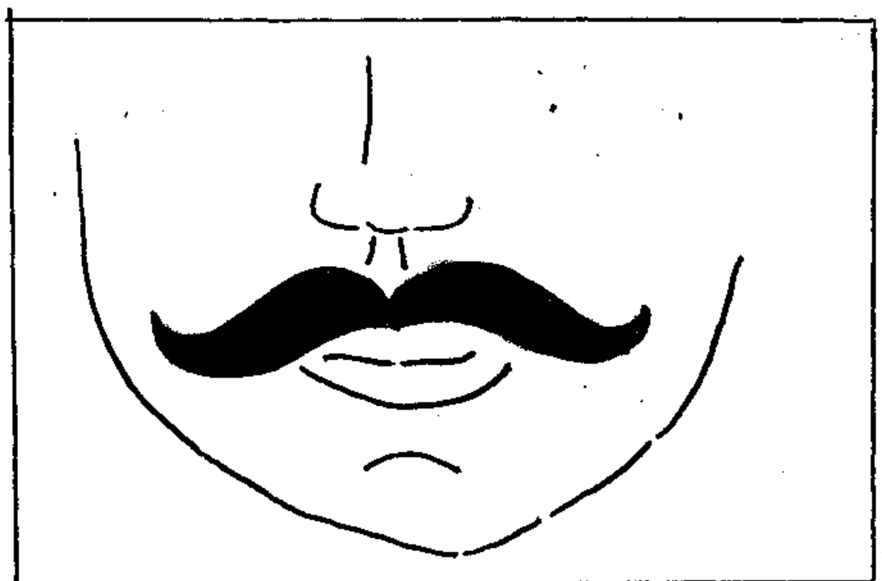

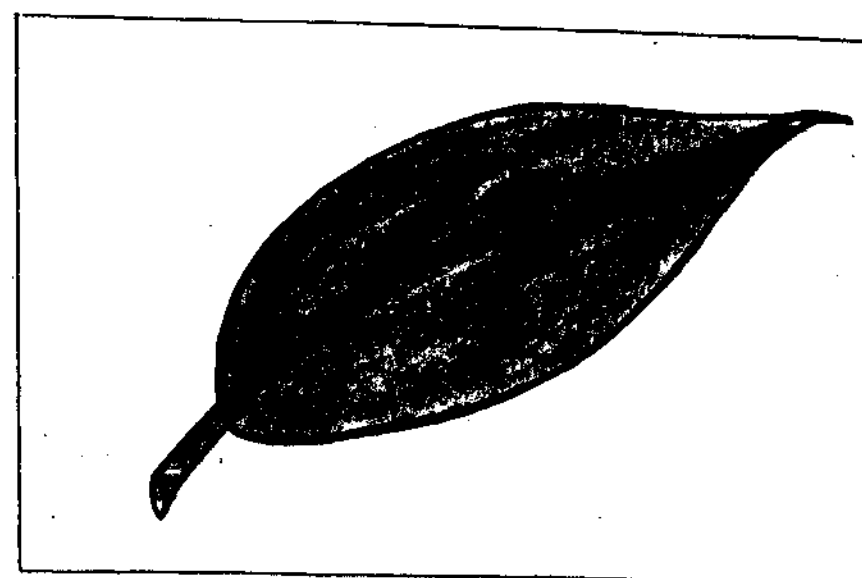

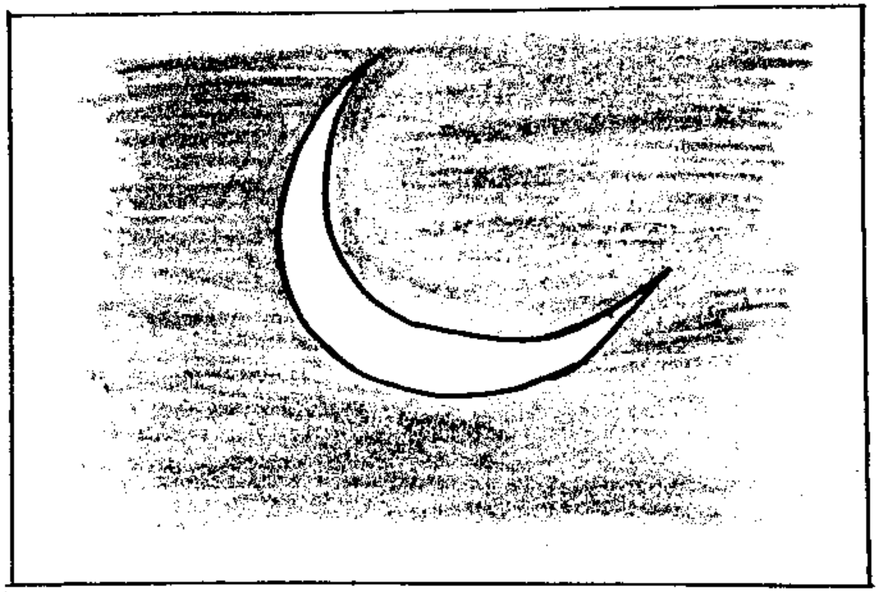

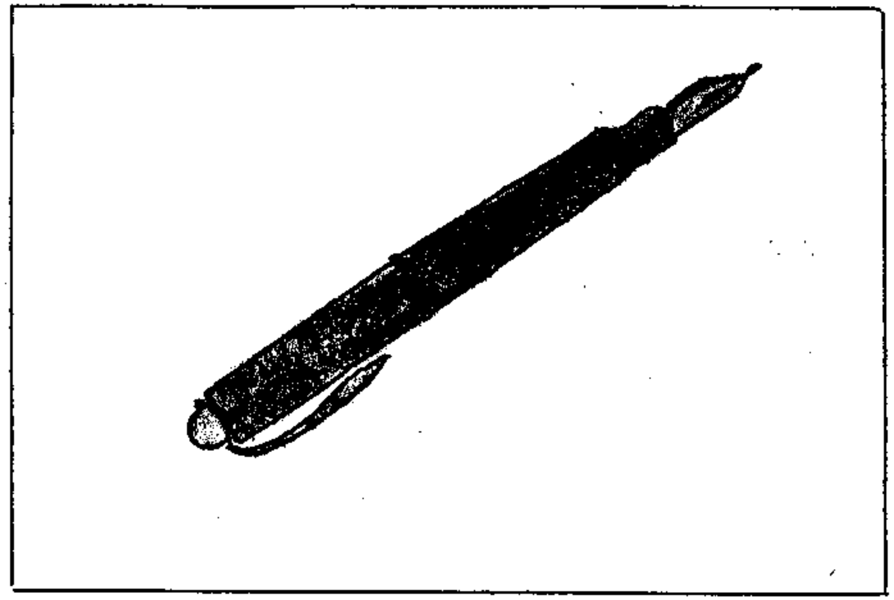

APPENDIX V

Calibration Procedure

Calibration of the Audiometer

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

Intensity Calibration

Intensity calibration for air conducted tones were carried out with the output of the audiometer set at 70 dB SL (ANSI, 1989). Through the earphones (TDH-39 with MX-41/AR ear cushions) the acoustic output of the audiometer was given to a condenser microphone (B&K 4144) which was fitted into an artificial ear (B&K 4152). The signal from the artificial ear was then fed in to a calibrated sound level meter (B&K 2209) with an octave filter set (B&K 1613) through a preamplifier (B&K 2616) using a half inch to one inch adapter (B&K DB 0962). The output SPL value was noted for frequencies 250 Hz through 8000 Hz and compared with the expected values according to ANSI Standard, 1989. if there was a discrepancy of more than 2.5 dB, it was corrected by means of internal calibration.

Bone Vibrator Calibration

Radio Ear B-71 (Bone conduction Vibrator) was calibrated for Frequencies 250 Hz through 4000 Hz. The output of the audiometer was set at 40 dB HL. From the bone conduction vibrator, the acoustic signal was fed to the artificial mastoid (B&K 4930). This output was then fed via a preamplifier to the SLM (B&K 2209). A difference of more than 2.5 dB between the observed SPL value and the expected value (ANSI Standards, 1989), was internally calibrated.

Frequency Calibration

The electrical output of the audiometer was fed in to the time/frequency counter (Radart 203) which gave a digital display of the generated frequency. If the difference between the dial reading on the audiometer and the digital display of a given frequency, exceeded + or - 3 % (ANSI, 1989) of the characteristic frequency tested, then an internal calibration was done.

Linearity Check

The linearity of the audiometer attenuator was checked. The intensity dial of the audiometer was set at maximum level and the frequency dial was set to 1000 Hz. The attenuator on the SLM was set at a level corresponding to the maximum level on the audiometer. The attenuator setting on the audiometer was decreased in 5 dB steps till 30 dB and the corresponding reading on the SLM was noted. For every decrease in the attenuator setting the SLM indicated a corresponding reduction.

Microphone Calibration

A 1000 Hz tone at 70 dB HL was presented as the microphone input for microphone calibration. The VU meter gain was set so that the needle peaked at 'O'. A one inch condensor microphone (B&K 4145) was connected to the SLM (B&K 2209) and octave filter set (B&K 1613). The output SPL was noted on the SLM on the linear scale and compared with the standards (Morgan et al. 1979). If the reading exceeded 2.5 dB, internal calibration was done.

Frequency Response Characteristics of Earphones

The frequency response characteristics of the TDH 39 earphone was obtained using signal generator (B&K 1023) pressure microphone (B&K 4145), frequency analyzer (B&K 2107) and a graphic level recorder (B&K 2616). The electrical output of the signal generator (B&K 1023) was fed to the headphone. The output picked up by the microphone (B&K 4145) was fed to the frequency analyzer (B&K 2107). This output was recordedon the graphic level recorder (B&K 2616).