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An Assessment of the Perception of Phonetic Ambiguities in 4 and 5 Year Olds

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An Assessment of the Perception of Phonetic Ambiguities in 4 and 5 Year Olds

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Abstract

The question of how humans clearly perceive speech, which is anything but clear when analyzed acoustically, has prompted researchers to look at the phenomenon of phonetic ambiguity. In adults, phonetic ambiguity perception has been shown to be aided by the listener using expectations due to the saliency (i.e., familiarity of the ambiguous word or phrase) and to pre-exposure (i.e., priming) to the items prior to testing. Priming makes the subject aware of the alternative (i.e., unfamiliar or rare) member of a phonetic ambiguity pair. In the present study, thirty-two 4 and 5 year olds were exposed to a tape containing familiar and rare ambiguity members and control items. One-half of them were primed. Results indicated that there was a strong beneficial effect of priming and saliency. The results of the present study were also compared with a previous adult study; this revealed a great deal of similarity between the two groups, implying 4 and 5 year olds can and do employ the same linguistic cues as adults.

An Assessment of the Perception of Phonetic Ambiguities in 4 and 5 Year Olds

Many theories of speech perception have been devised in attempts to explain how humans extract meaning from speech sounds. The difficulty of such a task is realized when one considers the complexity of language, itself. Within the constraints of a language, there still is an almost unlimited variety of sentences, clauses, phrases, and words possible. And, the speech production of these is almost as variable in nature as the speakers, themselves. However, no matter how unintelligent some persons may be, for the most part, they still are able to speak and listen with some effectiveness. Recent research focusing on the phrase, word, and word segment levels of speech has been conducted in order to shed some light on the enigma of speech perception.

One theory concerning the perception of isolated speech sounds contends that, during the auditory stage, the listener takes in short stretches of sound, makes preliminary auditory analysis of them, and puts this information into auditory memory. During the phonetic stage, the listener searches this memory for acoustic cues (features) and puts them together in order to identify a specific phonetic segment. He or she then

places this information in phonetic memory as an identification of the sound, but not the memory of the sound itself. Finally, during the phonological stage, the listener adjusts the memory to be in accordance with the constraints of the language. The final information is passed on to short term memory where it becomes conscious (Pisoni & Sawusch, 1975; Studdert-Kennedy, 1974, 1975). The major problem with this theory is, however, that in normal speech, there is no one-to-one mapping of stretches of the stream of speech onto a phonetic segment, nor is there a "standard" mapping of acoustic cues onto phonetic segments, nor are the acoustic cues the same under all conditions of speakers, intonation, or stress. How is it possible for a listener to understand all speakers of his or her language?

To solve this problem, it has been assumed that humans have an internal speech synthesizer which operates on a weak version of the motor theory of speech perception. That is, listeners abstractly model the speaker's articulatory gestures and, relying on acoustic cues which would result from that model, generate speech sounds for themselves which they match with incoming acoustic cues (Clark & Clark, 1977).

The above explanation is sufficient if the incoming

signals are unambiguous. However, in normal speech this is rarely the case. There is background noise. Speakers slur and leave out entire segments of words, and the appearance of the separation of words in the flow of speech is purely an illusion (Cole, 1979). Though unaware of it, listeners must be making guesses as to what the speaker has said, and the accuracy of these guesses in the adult suggests that more than random guessing is involved. When misperceptions do occur in casual speech, they are not random but show semantic and syntactic similarity with the speaker's actual expression (Garnes & Bond, 1975). Perception of acoustic cues alone based upon a data-driven ("bottom-up") process strategy cannot account for the perception of continuous speech. Therefore, Marslen-Wilson and Welsh (1978) contend that the perception of continuous speech is brought about by a combination of knowledge-driven ("top-down") and bottom-up processing strategies. Thus, they assert that:

> Human perceptual analysis of the speech signal must have a strong bottom-up component, since we usually hear what the speaker has said, rather than something else. But at some stage in the perceptual process there must also be important top-down effects, to enable us to compensate for missing and ambiguous lower-level information. (Marlsen-Wilson & Welsh, 1978, p. 31)

It is the perception of this ambiguous lower-level

information that is the concern of the present study. Ambiguity refers to any case in which a single stimulus is perceivable in more than one way. Several types of ambiguities arise in language. Syntactic ambiguities occur when the same words are perceived to be in different structural relations, such as "Visiting relatives can be boring." Lexical ambiguities occur with the words themselves and include such words as walk, change, and help. Ambiguity arises because walk, change, and help may serve either as nouns or as verbs. Phonetic ambiguities are the result of a given phonetic sequence (sound sequence) being interpreted in more than one way. Phonetic ambiguities may be further divided into phonological ambiguities and morpheme boundary ambiguities. Phonological ambiguities result when two phonetic seguences differ in a single phonological segment which distinguishes two words with different meanings (e.g., cracker/quacker). And, morpheme boundary ambiguities occur whenever a polysyllable can be interpreted as a single morpheme or as a sequence of morphemes (e.g., eight tea cups/eighty cups) (Hirsh-Pasek, Gleitman, & Gleitman, 1978).

The ability to detect and resolve ambiguity appears to be an important aspect of what one must know in order to comprehend and produce one's language. Therefore, a

study of the development of the ability to recognize ambiguity is a study of the development of linguistic competence (Shultz & Pilon, 1973). An assessment of the perception of phonetic ambiguities is an essential part of that study.

As mentioned previously, both top-down and bottom-up processing are considered necessary in order for one to compensate for ambiguous lower-level information. Studies into the perception of phonetic ambiguities have been conducted with adults. With such studies, two extreme positions have been taken. Lindsay and Norman (1977) used phonetic ambiguity to show that upper-levels of processing (semantic and syntactic) are necessary for one to choose word organization within phonetically ambiguous sentences. Derwing (1973) and Bolinger (1975) also take the position that upper-level processing is the critical factor in the ability to disambiguate at the phonetic level.

The opposite position which considers acoustic information to be of prime importance is taken by Lehiste (1960) who found that subjects could distinguish between members of phonetically ambiguous pairs in both sentence context and in isolation. Hoard (1966) excised ambiguities from connected speech and presented them with a list of alternatives to listeners. These

listeners were often correct in their choice of what the speaker intended (i.e., in over 50% of the cases).

Since opposite positions have found some support, some combination of the two levels is likely to be involved in disambiguation. Lieberman (1963), Morton (1966), and Thorne (1966) have developed this position. They propose that the care in the articulation of production and the use of available acoustic cures vary as a function of disambiguating constraints of the available contexts. Lieberman (1963) examined the effects of context through employing redundant and nonredundant sentences. Redundancy refers to the fact that parts of an utterance may be eliminated without impairing the listener's ability to comprehend the intended message. Redundance rests upon the fact that, provided the listener is given the first few words of a sequence, he or she can predict the next word with some real probability of being correct. Therefore, a sentence is judged to be redundant or nonredundant according to the percentage of words within it that can be correctly predicted by a group of listeners. The higher the percentage of words correctly guessed within a sentence, the more redundant that sentence; low percentages imply nonredundancy (Maher, 1973). Lieberman embedded words into redundant and nonredundant sentence contexts.

He then excised the words from the sentences and found that an acoustic analysis of the excised words showed that they were less clear acoustically and were harder to perceive when excised from the redundant sentence.

Thorne (1966) proposed that whenever acoustic cues and contextual constraints come into conflict, the semantic and syntactic levels would serve in resolving ambiguity more than would the acoustic level. To test this, he excised phonetic ambiguity members from context sentences and then placed the alternate member in each sentence. His hypothesis was supported; subjects reported that the member that they heard belonged to the sentence. Thorne's (1966) proposal was also supported by Winitz, LaRivirie, and Herriman (1973), who used context sentences which would lead the listener to anticipate the other member of the pair. Listeners inadvertently heard the member supported by the context of the sentence, not the actual member which was expressed.

This background in phonetic ambiguities lead Spencer and Wollman (1980) to extend Lieberman's (1963) procedure. So as not to covary acoustic differences in context with syntactic and semantic differences, they included single sentence frames in which each pair member would fit "(for example, 'He had a name/an aim which was unusual')" (Spencer & Wollman, 1980, p. 173).

Also, they raised the level of disambiguating context to prose (e.g., a short story about someone with an unusual aim). So, by producing the same ambiguity pairs as isolates, in sentence frames, and in the context of stories and then excising the pairs from these contexts and measuring subjects' ability to discriminate between the members, the influences on perception from the next higher level of analysis (i.e., prose) could be tested. They expected that pair members produced as isolated words would be the most accurately discriminated because there was no context to bias perception. Therefore, it was expected that the more context present, the more difficult it would be to distinguish pair members, with prose providing the most difficult condition. Results indicated, however, that this was not the case. Even in the isolate condition, listeners had great difficulty in detecting pair members. When they did hear a pair member, they did not hear the other member in any condition of context.

To find the cause of these strange results, Spencer and Wollman (1980) probed further. In their second study, production of the pairs was recorded in three conditions: stories read fluently, individual sentences read fluently, and one and two word items read. Results showed that the listeners failed to correctly identify

pair members in over 50% of the cases in all contexts, but each member was not perceived equally as often and what was heard incorrectly was quite variable. For example, responses for both ought included "Bertha," "favor," "per heart," and "their fault." Only 3% of the incorrect responses were of the other members. Listeners could fairly well identify the control words in all conditions except when excised from fluent speech. Misperceptions of control words were phonetically related to the items. For example, responses for praised it included "praised him," "raised them," and "praise did." The difference in perceptual accuracy in ambiguous and control words is attributed to phonetic ambiguities providing a relatively poorer acoustical support for lexical access than do the control words. The authors concluded that:

> In sum, the listener's problem with these phonetic ambiguities was not one of distinguishing which member had been presented or intended. Rather than resolving an indeterminancy, the listener's problem appeared to be more basic than the literature had lead us to believe. The problem that our listeners had was to perceive words in the acoustic array. One of the possible reasons for the discrepant results was that our listeners had no expectations of what words and phrases they might hear. (Spencer & Wollman, 1980, p. 179)

In order to find out why one form was perceived more frequently than the other, Spencer and Wollman (1980) required listeners to write down sentences which

contained one member or other of the pair. They were then asked to write the other member. The listeners had difficulty in finding the ambiguities, and they responded with a great variety of answers. When they did perceive a member, it was found to be the more salient (i.e., more familiar) member and was written more frequently than the less salient member even when the less salient member was the one presented.

The investigators then exposed the pairs to listeners prior to testing. Under this priming condition, listeners found perception and reversals of ambiguities easy to accomplish. Thus, pre-exposure (i.e., priming) to the ambiguities seems to have a strong influence on listeners' ability to identify them in speech. The authors concluded that priming appears to be of more importance to the identification of pair members than the level of context of the acoustic support. And, they posited that familiarity with the pair members influenced expectations which Thorne (1966) has shown influences perception.

Spencer and Carter (1982) conducted a study which varied context, familiarity, and priming in order to further explore this avenue of explanation of the perception of phonetic ambiguities. The new study varied context through embedding each member of each

pair into three types of context sentences: those biased toward the embedded member, those biased toward the other member, and those of neutral context. (See Appendix 4) Also a no context condition consisted of isolates excised from these sentences. Familiarity was varied in that one member of the pair was more salient than the other; the member of the pair which was more frequently encountered in everyday language and more frequently written as a response in the sentence writing study was considered the more salient member. Finally, priming was given to one group and not to another. Results indicated that for the isolate condition it does not matter whether the items were excised from neutral or biased sentences. (See Appendices 1 and 2) Therefore, data from the two tapes was combined. (See Appendix 1) These data indicated that the familiar form was written more frequently than the rare form in both priming and no priming conditions. The rare form was written much more frequently in the priming condition than in the no priming condition. Also, of note is that there were fewer "wrong" responses in the priming condition. A response was considered wrong if it was not a pair member or control item, depending upon the respective item. Obviously priming and familiarity had some influence in the perception of phonetic ambiguities.

It is under these isolate conditions that the present study attempted to assess the children's judgments of phonetic differences and similarities. As part of the knowledge a child has of a language, he or she must be able to attend to phonetic differences. It is known that children do possess some phonological knowledge of this type in their preschool years. If they did not, they would be unable to understand anyone who differed only slightly in production from themselves. Evidence about the nature of the development of phonetic judgments is sparse, but surely necessary if we are ever to understand fully how the child acquires language (Read, 1971).

Upon reviewing the paraphrases children 6 to 15 years of age gave to their sentences, Shultz and Pilon (1973) indicated that the development of the ability to detect what they termed "phonological" ambiguities begins some time before 6 years of age and reaches a peak in improvement between 6 and 9 years of age (i.e., from 10% correct paraphrase at age 6 to 58% correct at age 9). Hirsh-Pasek, Gleitman, and Gleitman (1978) criticized Shultz and Pilon's scheme for classifying ambiguities; Shultz and Pilon's definition of "phonological" ambiguity included homonyms and morpheme boundary ambiguities. They classified word pairs such

as lion/line (which do differ phonetically) and patience/patients (which do not differ phonetically) under the heading "phonological" ambiguity. In subjects who are illiterate (e.g., most 4 and 5 year olds), the difference in spelling between items could hardly have an influence in their perception of those words. Hirsh-Pasek et al. (1978) held that the differences in types of items within Shultz and Pilon's "phonological" ambiguity category would make conclusive interpretation of the results dubious. Thus, Hirsh-Pasek et al. suggested a more refined categorization scheme in which phonetic ambiguities were further divided into morpheme boundary ambiguities and phonological ambiguities. The Hirsh-Pasek et al. definition of phonological ambiguities was that they are phonetic sequences which differ only in one phonological segment and result in a change in meaning (e.g., writer/rider), and morpheme boundary ambiguities arise when the perception of the place of segmentation between morphemes is unclear (e.g., both thought/both ought).

Liberman, Shankweiler, Fischer, & B. Carter (1974) have indicated that 4 and 5 year old children are less likely to accurately segment meaningless phonemes than are adults and older children. None of the pre-kindergarten children could segment meaningless phonemes in

their study; 17% of the kindergarten age children could, while 70% of children at the end of the first grade could. However, in the course of language acquisition, meaningful phonemes are the first sequences to be abstracted by the child (Gibson & Levin, 1975). Since phonetic ambiguities result in a meaning difference, it was felt that this was not a source of difficulty in the perception of phonetic ambiguities for the 4 and 5 year olds.

The purpose of this study was to assess preschoolers' perception of phonetic ambiguity isolates, with the assumption that familiarity and priming aid in attempting to resolve acoustic ambiguities. Pilot testing revealed that it was feasible to use some of the isolate members presented to adult college students in the Spencer and Carter (1982) study. So, five morpheme boundary ambiguities, one phonological ambiguity, and nine control words from the tape used in that study were used.

A source of difficulty in working with pre-literate children is the fact that they cannot respond with or learn from the written form. To try to circumvent this problem subjects were asked to respond verbally and point to pictures illustrating the items.

Unfamiliarity with the members was also considered

to be a possible source of difficulty since it could interfere with the effects of salience. Therefore, during the phonetic ambiguity testing, the children were questioned as to their understanding of each member and control item.

Method

Subjects

Thirty-two native English speakers from the Richmond, Virginia, metropolitan area served as subjects. Through coin toss, 16 subjects were randomly assigned to each exposure condition, respectively (i.e., to either priming or no priming). Within the priming condition there were eight males (two 4 year olds and six 5 year olds) and eight females (six 4 year olds and two 5 year olds). Within the no priming condition there were ten females (six 4 year olds and four 5 year olds) and six males (three 4 and 5 year olds each). The range of ages was between 4 years, 0 months to 5 years, 11 months, with the median age of 4 years, 10 months. Two of the 5 year old females, one 4 year old female, and one 5 year old male were black. The other subjects were white. Three of the 4 year olds (a black male and female and a white female) were of lower-middle socioeconomic status; five of the 5 year olds (two black females, one black male, and two white females) were also of lower-middle socioeconomic status. The remaining subjects were of upper-middle socioeconomic backgrounds.

The sources of recruitment included area day-care centers and kindergartens, as well as the faculty,

graduate students, and undergraduate students of the psychology department of Virginia Commonwealth University.

Data from four candidates had to be rejected. Three children, two males and a female--all 4 year olds and white, could not participate in the phonetic ambiguity testing because they were unable to hear the tones presented during the Identification Audiometry at the criterion level of 25dB. (See Appendix 6) The fourth child, a black male of 4 years, 0 months could hear at the criterion level; however, he did not successfully perform the tasks of the phonetic ambiguity test.

Two female undergraduates in psychology (ages 29 and 19 years) and one female graduate student (25 years of age) served voluntarily as observers. The three were white and of middle socioeconomic status. They recorded the children's verbal responses and picture selections during the phonetic ambiguity tests. The 19 year old observed only two of the subjects. The 24 year old observed six of the subjects, while the 29 year old observed the remainder.

Apparatus

The Identification Audiometries and phonetic ambiguity tests were conducted in an IAC Single-walled

Chamber in order to minimize outside noise and distractions.

The Identification Audiometry's sole purpose was to screen subject candidates who had hearing impairment--not to establish exact thresholds. For this purpose a Lafayette 1977 Beltone D-Series Full Range Solid State Portable Audiometer, model Number 15014, calibrated according to American National Standards Institute (ANSI) 1969 Values, was employed. According to the manual accompanying the audiometer, "normal limits" of hearing has been established at "25 dB or better." The instructions to the subjects (also taken from the manual) and the Hearing Acuity Response Sheet are in Appendix 6.

The phonetic ambiguity isolate item tape was developed and graciously provided by Dr. Nancy J. Spencer. The tape was recorded at Haskins Laboratories on channel one on June 29, 1980. It is comprised of 89 items--isolated words and phrases excised from sentences (read by Dr. Lee Lisker) used in the Spencer and Carter (1982) adult study. Considering the age group under study, only 36 of the items were used. (See Appendix 5) Instead of simply tape recording the 36 needed items from the 89 in the Spencer and Carter tape, an attempt was made to maintain the fidelity of the presentations

made in that study. Thus, the original tape was used and the locations of the needed items (i.e., in tape player revolution numbers) were determined. Since the tape was never removed from the player throughout the study, this allowed the observer to advance the tape to the appropriate position for each item presented. Due to the variability of response durations of the subjects and to the variability of space between items, no standard inter-stimulus interval could be established.

In order to account for possible effects due to the differences in sound intensity of the various items, the sound intensity in dBSPLs (i.e., decibels expressed in sound pressure levels) was measured using a Bruel & Kjaer 2215 Precision Sound Level Meter Octave Analyzer, A scale. The meter was located approximately where it was estimated the typical child's head was located during the test--approximately 55 cm above the seat and approximately 50 cm from the tape player. In order to control for measurement error, the arithmetic mean of three measurements made for each item was recorded. The mean for each item is listed in Appendix 7.

The items were presented via a Sony Tapecorder TC-270, model number 22747, with its own two loudspeakers (35.5 x 25 cm each). Both speakers were employed.

Line drawings were used to represent each item visually. They are illustrated in Appendix 8. The actual picures are filled in with color. For each item presented, the investigator placed a posterboard (55.5 x 70 cm) in front of the child on a round table in front of both the investigator and child. Since the Wechsler Intelligence Scale for Children, Revised (WISC-R) has revealed that the memory capacity of children this age is sufficient to handle six items, each board contained six of these line drawings (two by three). In hopes of providing an adequate selection for each type of item (i.e., phonetic ambiguity and control), there were always members of two phonetic ambiguity pairs and two control items included on each board. When assembling the boards, the selection of which items would occupy which locations was specified as follows: The correct item was randomly assigned to one of the six positions. The corresponding pair member was placed to the left or right of that item. The other two item pairs were assigned in the same way. For the orders of picture presentation used, see Appendix 9.

In order to test inter-rater (inter-observer) reliability, cassette tape recordings were made during one session per observer. For this purpose a General Electric Three-way Power Cassette Recorder with

condenser microphone, model number 3-5100B, was employed with TDK Type D (i.e., for speech) Precision Mechanism Cassette tapes.

Procedure

A parent or guardian accompanied the child to the laboratory and was required to read and sign the Informed Consent form. (See Appendix 3) The investigator explained what the child would be doing and answered questions concerning the child's participation. Both the child and adult were told that, at any time, the child could stop for as long as necessary in order to rest, go to the restroom, etc. It was also explained that if the child simply did not want to participate, he or she would not be required to do so. No testing had to be interrupted or stopped. The only break taken was during a rest period always given between the audiometry and phonetic ambiguity test. This period lasted between 5 to 10 minutes. This gave the child time to rest and the investigator and observer an opportunity to set up the equipment for the phonetic ambiguity test. In order to make the child more comfortable, with permission from the adult, the child was allowed to bring in fruit juice or a soft drink (provided by the investigator) during testing.

Each adult was welcomed to attend the child in the

chamber if it was felt necessary by the child or adult. Those adults who did attend were invited to sit behind the child and asked to be as quiet as possible. Those not electing to do so simply waited on a couch or chair in the laboratory's living room.

Identification audiometry. Each child was taken into the testing chamber and asked to sit in the "big chair" (an adult-sized wooden chair with arms) to the right of the investigator. The audiometer was placed on the table in front of both of them. See Appendix 6 for the instructions given to the child and the procedure used. The entire audiometry procedure took approximately 5 to 10 minutes to complete.

Phonetic ambiguity test. If it was determined that the child was capable of hearing the tape, the phonetic ambiguity test could proceed. The child and investigator resumed their seats after the break period. The reel-to-reel tape player and accompanying speakers were located on a table 77 cm high and approximately 50 cm to the child's right. The speakers were placed approximately 50 cm apart. The child's head remained to the left of the speakers. The child remained in the same seat throughout the phonetic ambiguity test. This was done to insure that each child had an optimal chance of clearly hearing the tape.

Under both exposure conditions, the children were required to listen to the item presented over the speakers, tell the observer what was heard, explain what the item was, and point to a picture which represented the item.

For the no priming condition the investigator used the following instructions:

> We'll be playing another game. A man will be saying some words when I play the tape (points to the tape player). I want you to listen to each word and tell me or (name of observer) what he said. Then, I'll ask you what it means. If you see a picture on the table of what he said, point to it for me. We'll go through several words. When we're finished, you may pick out a book for yourself, and you may take it home and keep it.

The investigator then questioned the child by inquiring: "If the man says gasoline, what do you say?" The child was then asked what it was and to point to a picture if he or she saw one of it. If the child did not know what gasoline was, the investigator explained it to the child and then asked the child what it was. If the child still did not understand (one 4 year old

girl did not), another word was selected as the example. In this case, it was people. Once actual testing began, the investigator gave no explanation for an item not understood by the child. Explanations were given after testing for any items not understood. During the session if the child did not understand an item, the investigator told the child "that's O.K.; you're doing fine." The next item was then presented.

Under the priming condition, the above instructions were also given and the same procedure followed; however, the children in this condition were first primed by being pre-exposed to the phonetic ambiguity pairs. For each pair, the investigator placed the drawings of the pair members side-by-side on the table in front of the child, one pair at a time. The investigator then pointed to one of them and said the item that was represented. For example, when pointing to the picture of a heart, the investigator said "this one is sweetheart." The investigator then asked the child to repeat the item and explain what it meant. The investigator did the same for the other member of the pair. Anytime that the child was not familiar with an item during the pre-exposure, the investigator explained what the item was and asked the child if it was understood. When the child claimed to understand, the

investigator then again asked what the item meant. Only after the child could explain the meaning of each item did testing begin. The results for each item were recorded on the Phonetic Ambiguity Response Sheet. (See Appendix 10)

Inter-rater reliability. Since three observers wrote down the verbal responses for different children during the phonetic ambiguity tests, a cassette tape recording one session per observer was made in order to compare the observations of each. Each observer listened to the other two observers' tapes and wrote down the verbal responses of the children (i.e., the repetition of the item and the meaning given by the child). Since the tape listener did not have the benefit of seeing the child's lips, she was allowed to replay the tape until she was sure of what was said.

Inter-rater reliability is the number of disagreements divided by the number of agreements plus disagreements. In this study, agreement was defined as the recording of listener and observer of the same words (or sequence of sounds) and meanings being recorded. When the meaning of the words was taken into consideration, there was no disagreement among observers. In one case, the 24 year old recorded "wrider" while the 29 and 19 year olds recorded "rider";

however, all three recorded "riding on a bicycle" as the meaning. There were no other disagreements over meaning or repetition.

Results

The major concern of the present study was to determine the effects on the children's perception due to priming (i.e., no priming/priming) and word form (i.e., frequent and rare phonetic ambiguity members and control words). Since these effects were shown to occur in adults in the Spencer and Carter (1982) study, the data from this study were also analyzed.

In order to compare the effects of priming and word form on the children's versus the adults' responses, the following analyses were conducted: Since three control words and all phonetic ambiquity members were repeated once in presentation, several repeated measures 2 by 3 Analysis of Variance tests (ANOVAs), using number correct or number of other phonetic ambiguity members as dependent measures, were performed.

For the children's data, all 36 items were included in the ANOVA employing number correct as the dependent measure. An item was considered to be correct if the meaning given by the child corresponded to the item presented, even though the verbal repetition or picture selection did not. If the meaning did not correspond, the response was considered incorrect, even if the verbal repetition and/or picture selection corresponded

to it. Although the effect of age group in the children (i.e., 4 or 5 year olds) was not manipualted directly in this study, its effects were also analyzed. The summary for this ANOVA is presented in Table 3. The main effect of priming was found to be significant (F (1,28 = 11.82, p. .002). Those subjects who were primed to the phonetic ambiguity members prior to testing responded correctly to significantly more of both phonetic ambiguity and control items than did those subjects not primed. ($\bar{X}$ = 24.15 and $\bar{X}$ = 19.44, respectively, S.D. = 3.72).

There was also a significant difference between means for the three types of word form (i.e., control items, and frequent and rare phonetic ambiguity items) (F (2,56) = 94.33, p < .0001). And, the interaction of word form and priming effects was also significant (F(2,56) = 7.53, p < .01). (See Appendix 12, Figure 1) This illustrates that a greater difference between the frequent and rare means and between the frequent and control means occurred in the priming condition. A post hoc analysis with a Duncan's New Multiple Range test on the three word form means revealed a significant difference between all three groups at the .05 level of confidence. An examination of the means in Table 4 indicates that the mean for control items was greater

than for the ambiguity members, and the mean for the frequent form was greater than for the rare form of the phonetic ambiguities.

Table 3

Summary Table for the ANOVA on the Number of Correct Responses for the Children's Data

Source	SS	df	F	p
Priming	49.59	1	11.82	<.002
Age Group	8.76	1	2.09	<.16
Priming x Age Group	.09	1	.02	<.88
Error (Subject (Priming x Age Group))	117.46	28		
Word Form	820.02	2	94.33	<.0001
Word Form x Priming	65.44	2	7.53	<.001
Word Form x Age Group	7.56	2	.88	<.42
Word Form x Priming x Age Group	.81	2	.09	<.91
Error (Subject x Word Form (Priming x Age Group))	243.42	56		
Total	1313.24	95		

Table 4

Results of Duncan's New Multiple Range for the Main Effect of Word Form for the Children's Data

Word Form:	Control	Frequent	Rare
	N = 32	N = 32	N = 32
Mean:	9.84	8.63	3.13

Neither the main effect of age group nor any of its interactions was significant.

For the adults' data, only the 36 items presented to the children entered into the analysis using number correct as the dependent measure. With the adults' responses, an item was considered correct if it was simply written as the item presented. The summary table for this ANOVA is presented in Table 5. As already noted, the adults performed significantly better when primed than when not (F (1,64) = 14.33, p <.0003). ($\bar{X}$ = 28.83 amd $\bar{X}$ = 25.52, respectively, S.D. = 2.99). And, as with the children's data anylysis, analysis of the adults' data revealed a significant difference between means of the three types of word form (F (2,64) = 141.04, p < .0001). The interaction of priming x word form was also found to have a significant influence (F (2,64) = 81.46, p < .0001). (See Appendix 12, Figure 2) Improvement in the adults' rare number correct is clearly demonstrated, while little or no difference in the frequent and control items may be attributable to priming. Another Duncan's group comparison was performed yielding a similar pattern as that for the children; the mean of the control items was significantly greater than that for the frequent items

which, in turn, was significantly greater than the mean for the rare. Significance was established at the .05 level of confidence. (See Table 6)

Table 5

Summary Table for the ANOVA on the Number of Correct Responses for the Adults' Data

Source	SS	df	F	p
Priming	27.88	1	14.33	.0003
Word Form	548.51	2	141.01	.0001
Word Form x Priming	81.46	2	20.94	.0001
Error (Subject x Word Form (Priming)	202.06	64		
Total	860.01	69		

Note. A General Linear Models analysis was employed when performing the ANOVA due to the unbalanced number of subjects per priming condition (i.e., for priming N=12, for no priming N=21).

Table 6
Results of Duncan's New Multiple Range for the Main Effect of Word Form for the Adults' Data

Word Form:	Control	Frequent	Rare
	N = 33	N = 33	N = 33
Mean:	11.70	9.09	5.94

The children and adults often responded with the _other_ member when a phonetic ambiguity item was presented; therefore a separate analysis using the occurrence of the other member as the dependent variable was also performed for both subject groups. Of course, only the 24 items which were phonetic ambiguities were entered into the analysis.

The summary table for the ANOVA of the children's responses is presented in Table 7. The main effect of word form was found to be significant (F (1,28) = 73.6, p <.0001.) A subsequent Duncan's post hoc analysis was done to determine the direction of the effect; with a .05 level of confidence, the other members were selected significantly more often when the rare members were the ones actually presented than when the frequent members were presented. (See Table 8)

Table 7

Summary Table for the ANOVA on the Number of Other Members Selected by the Children

Source	SS	df	F	p
Priming	6.25	1	3.74	<.06
Age Group	.00	1	.00	<1.00
Priming x Age Group	1.00	1	.60	<.45
Error (Subject (Priming x Age Group))	46.75	28		
Word Form	351.56	2	73.60	<.0001
Word Form x Priming	60.06	2	12.57	<.001
Word Form x Age Group	.06	2	.01	<.91
Word Form x Priming x Age Group	1.56	2	.33	<.57
Error (Subject x Word Form (Priming x Age Group))	133.75	28		
Total	600.94	67		

Table 8

Results of Duncan's New Multiple Range for the Number of Other Members Selected by the Children

Word Form:	Frequent	Rare
	N = 32	N = 32
Mean:	1.53	6.22

The interaction of word form and priming had a significant effect on the selection of the other member (F (1,28) = 12.57, p <.0001). (See Appendix 12, Figure 3) Thus, even though the other member was largely given for the rare presentations, priming appears to widen this gap between the rare and frequent items. However, priming had only a marginal effect (F (1,28 = 3.74, p .06), ($\bar{X}$ = 8.36 under priming and $\bar{X}$ = 7.13 under no priming, S.D. = 3.09), while none of the age group interactions were significant.

The summary table for the ANOVA of the adults' selection of other members is presented in Table 9. In line with the children's data analysis, the analysis of the adults' responses indicated a strong main effect of word form (F (1,32) = 65.92, p <.0001) ($\bar{X}$ = 2.46 under priming and $\bar{X}$ = 2.02 under no priming, S. D. = 1.77) as well as a strong word form x priming interaction (F (1,32 = 14.57, p <.0006). (See Appendix 12, Figure 4) Here priming appears to slightly lessen the distinction between frequent and rare members in the selection of the other member. Performance of a Duncan's post hoc analysis revealed the same direction of effect as in the children's responses. Table 10 contains the adult results. The other member was selected significantly

more often when the rare member was presented than when the frequent member was presented. This significance was determined at the .05 level of confidence.

Table 9

Summary Table for the ANOVA on the Number of Other Members Selected by the Adults

Source	SS	df	F	p
Priming	2.88	1	1.96	<.17
Word Form	98.97	1	65.92	<.0001
Word Form x Priming	21.43	1	14.57	<.0006
Error (Subject x Word Form (Priming)	67.03	32		
Total	188.31	35		

Note. A General Linear Models analysis was employed when performing the ANOVA due to the unbalanced number of subjects per priming condition (i.e., for priming N=12, for no priming N=21).

Table 10

Results of Duncan's New Multiple Range for the Number of Other Members Selected by the Adults Due to the Main Effect of Word Form

Word Form:	Frequent	Rare
	N = 33	N = 33
Mean:	.97	3.39

Table 11

Pearson Product Moment Correlations between the Dependent Variables amd Sound Levels

Dependent variable	No Priming		Priming	
	Adult	Children	Adult	Children
No. correct	-.13	+.14	-.07	-.38
No. Other	.00	+.08	+.10	+.05

Sound Intensity Levels

To ascertain whether there was any relationship between the dependent variables (i.e., number correct or number of other members selected) and the sound intensity levels of each item, in dBSPLs, eight Pearson Product Moment Correlations were performed. The results are shown in Table 11. The only correlation of real note is the mild inverse relationship between sound intensity and number correct for the children under the priming condition (r = -.38). All other correlations were too low to reflect any significant relationship between sound intensity level and either of the dependent measures. A Coefficient of Determination of this highest correlation indicated that 85.56% of the variance in this experiment was attributable to other sources.

Item Analyses

As a further comparison of the children and adults an item analysis of their responses was performed concerning the number and percentage of items they correctly identified. The results are listed in Appendix 11, Table 12. Taking both the initial and repeat presentations into account, a rank ordering of the phonetic ambiguity members from this list revealed

that under both priming conditions, the children correctly identified market and writer most often. For the adults in the no priming condition, sweetheart and may cry proved to be the easiest to identify, while under the priming condition, sweetheart, may cry, and make rye were the ones to be correctly identified most often.

At the opposite end of the ranking, both thought, both ought, and mark it were the most difficult for the children to correctly identify under both priming conditions. Under the no priming condition for the adults, an aim, both ought, and mark it were the most difficult; under the priming condition, an aim, mark it, and writer were the hardest to identify.

Again, since the other members were frequently selected by adults when phonetic ambiguities were presented in the Spencer and Carter (1982) study, the selections of the other member by the children was also examined.

The number and percentage of other members selected for each phonetic ambiguity item presented was determined for the children and adults in both priming conditions. The results are listed in Table 13. (See Appendix 11)

Under the priming condition, rank ordering of the

children's responses (considering both presentations of each member) revealed that the largest number of reversals were made when mark it and writer were presented. The fewest reversals occurred when may cry and a name were presented to subjects under the no priming condition. With priming, the fewest selections of the other member were made with may cry and both thought.

The most reversals for the adults in the no priming condition occurred with mark it, while for the priming condition, mark it and rider caused the most reversals. Sweetheart, a name, both thought, and may cry, all of equal ranking, caused the least number of reversals under both conditions of priming.

Incorrect responses (i.e., wrong responses, not including other responses) for the phonetic ambiguity items were also examined as a source of comparison of the adults and children. For the children, 25.08% of the total responses were categorized as being wrong, including no response being given at all. No responses accounted for 7.85% of the total responses. For the adults, 17.09% of the total responses were wrong and 6.14% were no responses.

Although a large number of their wrong responses were classified as no response, the children did respond

with several alternative words and phrases. There were fewer responses in the priming condition than in the no priming condition (i.e., 11.02% and 5.21% incorrect, respectively); however, both words and nonwords were recorded for both. Resulting in the largest amount of incorrect responses, both ought, both thought, and make rye yielded such responses as "buzz saw," "bozo," "Luther," "make ride," and "make cry." The children often responded with simple sequences of sounds (i.e., nonwords) such as "botat," and "bossa." In the no priming condition, the nonwords comprised 33.08% of the wrong responses, while words accounted for 3.85%. In the no priming condition, words and nonwords accounted for almost equal portions of the wrong responses (22.31% and 23.08%, respectively).

Nonword responses for the adults resulted mainly from both thought, both ought, and market and included responses such as "buthoi," "bothorp," "boostful," "margit," and "marget." Real word responses included "blue foot," "brothel," and "Luther."

When misidentifying control words, both adults and children responded with words which were phonetically similar to the presented item. For example, "thanks" was a frequent reply to banks. Only three responses, given by the children, were nonwords. These were

"peaput" for _people_ and "skanks" and "jikes" for _banks_. These also bear phonetic resemblance to their corresponding item.

Finally, Pearson Product Moment Correlations were computed respectively for the number correct of the first and second presentations and for the number _other_ selected. These correlations were high. For the children the results were: _r_ = +.85 for the number correct responses and _r_ = +.96 for the number _other_. For the adults, the results were _r_ = +.90 and _r_ = +.90 and _r_ = +.88, respectively. Subsequently, the order of presentation was judged not to be a significant source of influence on the two dependent measures.

Discussion

As supported in the adult studies of Spencer and Wollman (1980) and Spencer and Carter (1982), the results of the present study reveal that the perception of phonetic ambiguities in 4 and 5 year olds is significantly facilitated when expectations concerning the identity of these items have been induced by priming; the predicted positive effect of saliency (i.e., familiarity) is also evidenced by the children's responses, and the interaction of the two effects is also quite strong.

Recall that the adults in the Spencer and Carter study were presented with 89 items, while the children in the present study were only presented with 36 items. For this reason and others, homogeneity of variance of both groups could hardly be assumed; so the control of error afforded by a 2 x 3 x 2 ANOVA, employing age (i.e., adults versus children) as a separate independent variable, could not be achieved. However, visual inspection of the results of the separate performed ANOVAs, of the item analyses, and of the strongly suggested trends in Table 1, Appendix 1, shows a striking similarity in the perception of phonetic ambiguities in the two age groups. Both adults and

children were shown to be strongly aided by priming and familiarity in correctly identifying the items. Both also responded with a significant majority of reversals being in the direction of the familiar form. And, for both, the influence of sound intensity level was minimal to nil. As did the adult subjects who were not primed, the non-primed children in the present study had greater difficulty in identifying phonetic ambiguity members than control items. Further, when not primed, the children gave more wrong responses and of a larger variety (i.e., more nonword responses) than when primed. However, under both conditions of priming, they gave more of these nonword and wrong word responses than the adults. Also of note is that the children refused to respond in over 7% of the cases categorized as wrong, approximately 75% of which were phonetic ambiguity items. The adults refused in 6% of the cases. These last few points give support to the position that for 4 and 5 year olds, as well as for adults, phonetic ambiguities provide a poorer acoustical support for speech perception than do control words, even though both groups' responses demonstrated phonetic resemblances to the correct item. (See Spencer & Wollman, 1980.)

While keeping in mind the similarities, there are

some differences worth noting. For example, the correct response mean scores were lower for the children than for the adults. Also, when failing to respond to an item, the adults routinely said that the sounds that they heard were gibberish (this was in the no priming condition). However, when the children refused to respond in either condition, they were unable to report why they failed to respond. This may reflect a less degree of metalinguistic and metacognitive sophistication in the young age group when a clear perception does not become immediately available. Since they are pre-operational, in the Piagetian sense, they do not naturally reflect on such abstract matters. However, the lack of the necessity for such knowledge in order to communicate effectively at this age is demonstrated by the fact that none of the subjects appeared able to do it, yet they were clearly understood by all present.

Even though it is prudent to point out the differences in the responses of the two groups, the strength of the impact of the same factors on both groups far outweighs the differences. Such similarities suggest that children as young as 4 years of age are capable of using language cues, as do adults, in their attempts to understand others. Further, that they do so spontaneously is evidenced by the fact that familiarity

had a strong influence in their correct identifications under the no priming condition. And, they show that they can implement the awareness of alternative perceptions, as evidenced in the priming condition. Thus, while perhaps not as proficient as the adults in the use of these cues and not as aware of what they, themselves, know about language, it has here been shown that these young children are capable of making clear perceptions out of very distorted (i.e., ambiguous) speech. And, they do so in much the same manner as adults.

List of References

List of References

Bolinger, D. Aspects of language (2nd ed.). New York: Harcourt Brace Jovanovich, 1975.

Clark, H. H., & Clark, E. V. Psychology and language: An introduction to psycholinguistics. New York: Harcourt Brace Jovanovich, 1977.

Cole, R. A. Navigating the slippery stream of speech. Psychology Today, 1977, 12, 77-87.

Derwing, B. L. Transformational grammar as a theory of language acquisition: A study in the empirical, conceptual and methodological foundations of contemporary linguistics. New York: Cambridge University Press, 1973.

Garnes, S., & Bond, Z. S. Slips of the ear: Errors in perception of casual speech. In Papers from the Eleventh Regional Meeting, Chicago Linguistic Society, 1975, 214-225.

Gibson, E. J. & Levin H. The Psychology of reading. Cambridge, MA: M.I.T. Press, 1975.

Hirsh-Pasek, K., Gleitman, L. R., & Gleitman, H. What did the brain say to the mind? A study of the detection and report of ambiguity by young children. In A. Sinclair, R. J. Jarvella, & W. J. M. Levelt (Eds.), Springer series in language and communication (Vol. 2). New York: Springer-

Verlag, 1978.

Lehiste, L. An Acoustic phonetic study of internal open juncture. Phonetica, 1960, 5 (Supplement), 1-54.

Lindsay, P. H., & Norman, D. A. Human information processing (2nd ed.). New York: Academic Press, 1977.

Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. Explicit syllable and phoneme segmentation in the young child. Journal of Experimental Child Psychology, 1974, 18, 202-212.

Lieberman, P. Some effects of semantic and grammatical context on the production and perception of speech. Language and Speech, 1963, 6, 172-187.

Morton, J. Discussion of On Hearing Sentences. In J. Lyons & R. J. Wales (Eds.), Psycholinguistics papers. Edinburgh: University of Edinburgh Press, 1966.

Pisoni, D. B., & Sawusch, J. R. Some stages of processing in speech perception. In A. Cohen & S. G. Nootebloom (Eds.), Structure and process in speech perception. Heidelberg, W. Germany: Springer-Verlag, 1975, pp. 16-34.

Read, C. Pre-school children's knowledge of English phonology. Harvard Educational Review, 41(1), 1971, pp. 1-34.

Shultz, T., & Pilon, R. Development of ability to

detect linguistic ambiguity. Child Development, 1973, 44, 728-733.

Spencer, N. J., & Wollman, N. Lexical access for phonetic ambiguities. Language and Speech, 1980, 23 (2), 171-198.

Spencer, N. J., & Carter E. A. Hearing intended and unintended words from fluent speech. Paper presented at Session in Sensation and Perception "Cambridge," Friday, March 26, 1982 (11:00-11:15 a.m.). 1982 Meeting of the Southeastern Psychological Association; Hilton Hotel, New Orleans, La.

Studdert-Kennedy, M. The perception of speech. In T. A. Seabeok (Ed.), Current trends in psycholinguistics, Vol. 12: Linguistics and adjacent arts and sciences. The Hague: Mouton Publishers, 1974, pp. 2349-2355.

Studdert-Kennedy, M. Speech perception. In N. J. Lass (Ed.), Contemporary issues in experimental phonetics. Springfield, Ill.: Charles C. Thomas, 1975, pp. 243-293.

Thorne, J. P. On hearing sentences. In J. Lyons & R. J. Wales (Eds.), Psycholinguistics papers. Edinburgh: University of Edinburgh Press, 1966.

Winitz, H., La Rivirie, C., & Herriman, E. Perception of word boundaries under conditions of lexical bias. Phonetica, 1973, 27, 193-212.

Appendix 1

Table 1

Adults' Isolates

Combined Data of Neutral and Biased Tapes[a]

No Priming

	Correct	Other Member	Wrong
Familiar[b]	75	4	21
Rare	36	36	28

Priming

	Correct	Other Member	Wrong
Familiar	73	18	9
Rare	68	25	7

[a] In percentage

[b] Member presented

Appendix 2

Table 2

Adults' Isolates

Respective Data of Neutral and Biased Tapes[a]

No Priming[b]

Neutral

	Correct	Other Member	Wrong
Familiar[c]	75	4	21
Rare	37	38	26

Biased

	Correct	Other Member	Wrong
Familiar	75	4	21
Rare	37	32	31

[a] In percentage

[b] In the priming condition--no difference between neutral and bias source tape

[c] Member presented

Appendix 3

INFORMED CONSENT

4 AND 5 YEAR OLDS'
UNDERSTANDING OF SPOKEN LANGUAGE

INVESTIGATOR:
ELIZABETH A. CARTER

The purpose of this study is to understand a small part of how children go about perceiving and sometimes misperceiving what people say. Your child will be hearing words and groups of words. I want the child to listen to them naturally as he/she would in a conversation. The child will be playing a game with me. I will play the tape and ask him/her to tell me what he/she hears on the tape, to describe it, and to point to a picture representing it. I will explain the procedure in more detail before the experiment.

The experiment is brief and involves no discomfort. It is not a test of intelligence, achievement, or reasoning abilities. It is simply an attempt to assess how 4 and 5 year olds perceive speech. The data will only be used to increase scientific understanding of communication that naturally occurs in everyday speech. All data will be coded by number so that no participant can be identified. All information collected will be kept completely confidential. It is most likely that your child will find his/her participation to be fun and interesting. I'll answer any questions you or your child may have about his/her participation. And I will explain to you when we are finished what I hope to find out about how youngsters comprehend speech.

If you like, I'll send a copy of the final paper to you when the study is over. Without penalty, you or your child may withdraw your child's participation in the experiment if you feel the need to do so.

I agree for my child to participate in this experiment under the conditions described above.

Name_____ Date_____

Witness_____ Date_____

Appendix 4

Sentence Sources of Phonetic Ambiguity Isolates

Set# Sentences

*1. Mark Twain was a writer. (BF)
At the rodeo there was a rider who would get on anything. (BR)
She was a writer/rider who had a lot of skill. (NBM)

2. The customers looked at the new display in the window. (BF)
The righteous moralists demanded that the nudist play be censored. (BR)
The people didn't like the new display/nudist play.

*3. The other boys kidded him about having a sweetheart. (BF)
The dieter felt guilty as he munched on a sweet tart. (BR)
He wanted to have a sweetheart/sweet tart. (NBM)

4. Doctors worry about patients deciding to sue them. (BF)
The minister at the funeral tried to soothe them. (BR)
The choice was to ignore them or to sue them/soothe them. (NBM)

*5. The foreigner had a name which was hard to pronounce. (BF)
He had an aim which never missed the bulls eye. (BR)
He had a name/an aim which was unusual. (NBM)

*6. They both thought about the argument. (BF)
The wife asked the therapist if they both ought to come. (BR)
This time they both thought/both ought to do it. (NBM)

*7. The strawberries went to market late in the season because of bad weather. (BF)
There would be a fine as the librarian was going to mark it late. (BR)
They were going to market/mark it late. (NBM)

*8. When babies are awake they may cry for no apparent reason. (BF)
They make rye with seeds at the Jewish bakery. (BR)
It looked like they may cry/make rye. (NBM)

Note: Context type: biased = B, neutral = N.

Word form: familiar = F, rare = R, both members = BM.

Item within sentence: * = used in the present study.

Appendix 5

Presentation Order of the Items Used in the Present Study

1. people
2. banks
3. sweet tart (R)
4. market (F)
5. gasoline
6. writer (F)
7. a name (F)
8. both thought (F)
9. cracks in the glass
10. market (F)
11. bad weather
12. sweet tart (R)
13. may cry (F)
14. both ought (R)
15. rider (R)
16. a name (F)
17. gasoline
18. make rye (R)
19. mark it (R)
20. daisies
21. an aim (R)
22. both ought (R)
23. match
24. writer (F)
25. sweetheart (F)
26. may cry (F)
27. an aim (R)
28. mark it (R)
29. both thought (F)
30. rider (R)
31. sweetheart (F)
32. make rye (R)
33. people
34. prisoners
35. banks
36. drink

Note: Pair member type: Rare = (R), Frequent = (F)

Since the Adult Study tape contains more items than needed in the present study, the tape was fast forwarded where there were several unused items.

Presentation Order of the Items Used in the Adult Study

1. people
2. choose
3. banks
4. panic
5. sweet tart
6. market
7. late
8. engineers
9. gasoline
10. writer
11. a name
12. unusual
13. toll booths
14. childhood
15. both thought
16. mistakes
17. new display
18. cracks in the glass
19. our view
20. soothe them
21. teenage softeners
22. market
23. bad weather
24. sweet tart
25. may cry
26. both ought
27. do it
28. custom
29. nearly escaped
30. new display
31. any minute
32. wake up
33. creek rose
34. salesperson said
35. rider
36. thirteen
37. childhood
38. did it
39. died
40. a name
41. pronounce
42. engines
43. gasoline
44. shoplifting
45. make rye
46. mark it
47. daisies
48. a name
49. unusual
50. both ought
51. match
52. custard
53. toddlers
54. sue them
55. writer
56. thirteen
57. wake down
58. minute
59. sweetheart
60. teenagers often wash
61. days
62. nudist play
63. may cry
64. bullseye
65. an aim
66. mark it
67. balogna
68. city lights
69. do it
70. both thought
71. crackers and glass
72. our view
73. rider
74. doodles
75. balcony
76. city lights
77. nudist play
78. picnic
79. sweetheart
80. soothe them
81. pink rose
82. salesperson's head
83. make rye
84. people
85. choose
86. prisoners
87. banks
88. drink
89. sue them

Appendix 6

Hearing Acuity Response Sheet

Subject name_____

Subject number_____Date_____

500 Hz Left Ear_____ Right Ear_____

1,000 Hz Left Ear_____ Right Ear_____

4,000 Hz Left Ear_____ Right Ear_____

If the child hears the tone, mark the space with a check ( ).

If the child does not hear the tone, mark the space with an X ( ).

AUDIOMETRY INSTRUCTIONS

I. Preliminary Testing

The investigator first seats the child so that he or she cannot see the controls of the audiometer.

(The investigator holds up the headphones.) "I am going to place these earphones on your ears. Once in a while, you will hear little beeps like this." (The investigator turns the decibel dial to 100 dB and the frequency dial to 1,000 Hz and then presents the tone with the earphones in hand.) "Every time you hear these little beeps point to the ear that hears it, then put your hand down and wait for the next beep." "Do you understand?" "Listen carefully."

During the acuity testing, the tone reversal dial is to be set to the "off" position. The earphones are then to be placed on the child's head and the earphone output selector is set for the right ear (red phone) and the decibel dial is first set for 40 dB with the frequency dial at 1,000 Hz.

This is done so that the child's understanding of the instructions can be tested. The investigator then presents the tone for approximately one second and asks the child to respond. Once the investigator is sure that the child understands the task, actual testing may begin.

II. Actual Testing

The test is conducted by presenting the tone for approximately one second at 25 dB in one ear and then the other. The child is tested at 500 Hz, 1,000 Hz, and at 4,000 Hz. These responses are recorded on the Hearing Acuity Response Sheet. If the child passes all three frequencies, then the ambiguity testing may begin. If the child has impairment on any of the frequencies tested, the testing is to be discontinued and the child is given a choice among several books. The investigator is not to alarm the parent but is to inform the parent that there is reason to believe the child has some hearing impairment at the tested frequency(ies). The parent should be taken through each step of the testing procedure by listening to the tone at the decibel level(s) the child could hear and then at the criterion of 25 dB. The parent is then to be referred to the family physician for further information.

Appendix 7

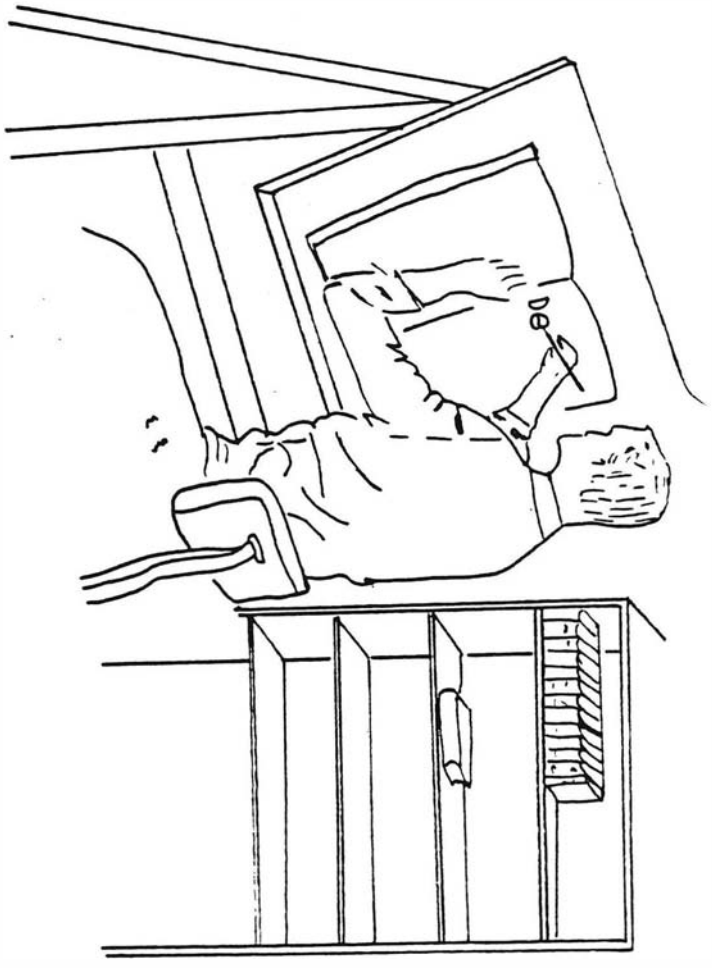
Peak Sound Levels of Items to the Nearest Whole Number

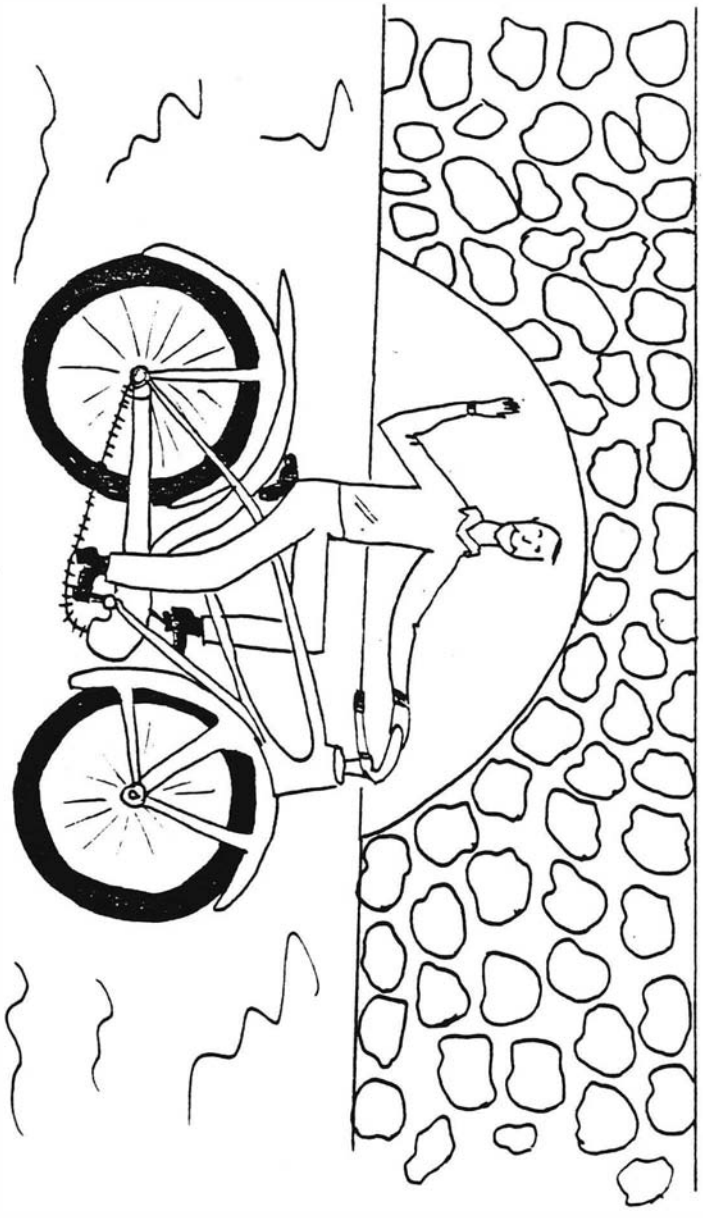
Baseline (i.e., simply with tape player on but not running tape): 30 dBSPL

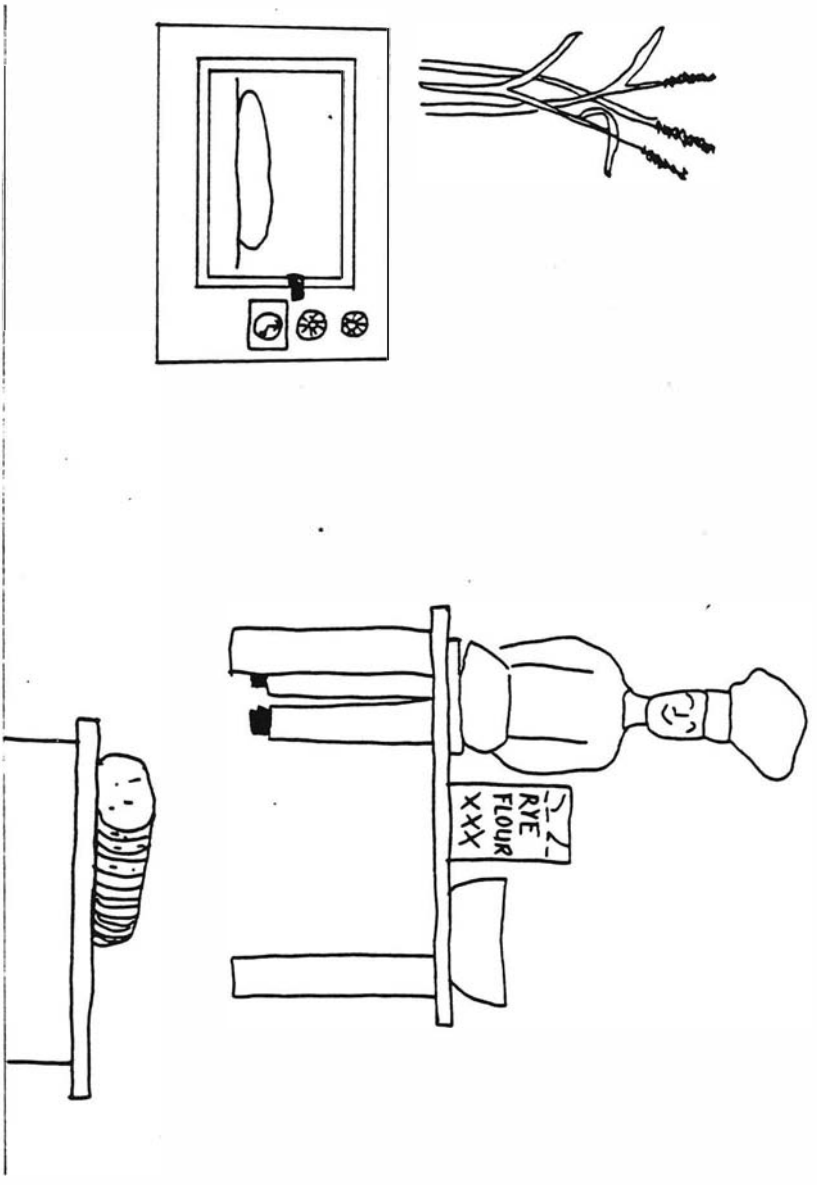
	Item	Mean Peak dBSPL
1.	people	69
2.	banks	66
3.	sweet tart	68
4.	market	70
5.	gasoline	69
6.	writer	70
7.	a name	73
8.	both thought	69
9.	cracks in the glass	76
10.	market	72
11.	bad weather	68
12.	sweet tart	72
13.	may cry	74
14.	both ought	69
15.	rider	76
16.	a name	72
17.	gasoline	70
18.	make rye	70
19.	mark it	73
20.	daisies	74
21.	an aim	72
22.	both ought	68
23.	match	67
24.	writer	75
25.	sweetheart	70
26.	may cry	75
27.	an aim	74
28.	mark it	65
29.	both thought	70
30.	rider	75
31.	sweetheart	69
32.	make rye	72
33.	people	69
34.	prisoners	70
35.	banks	70
36.	drink	67

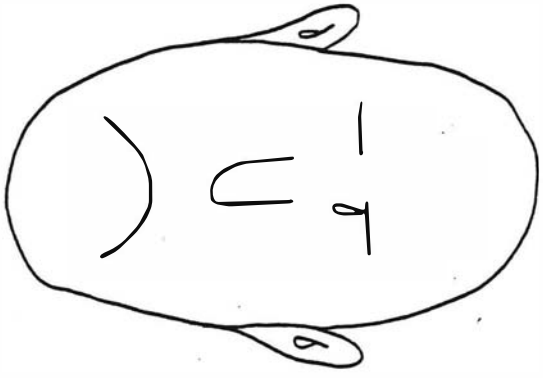
Appendix 8

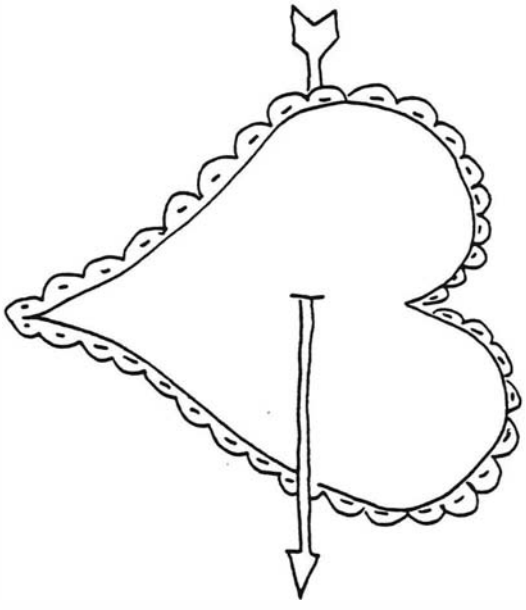
List of Line Drawings



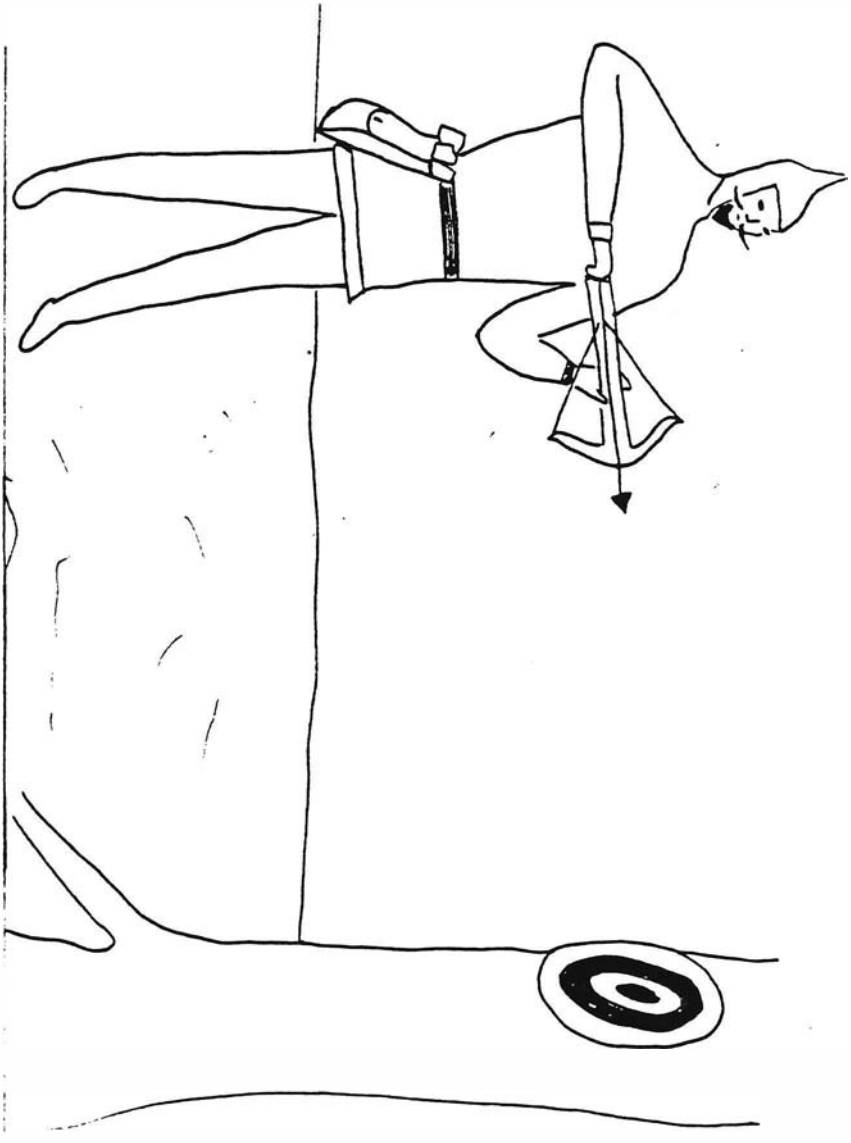


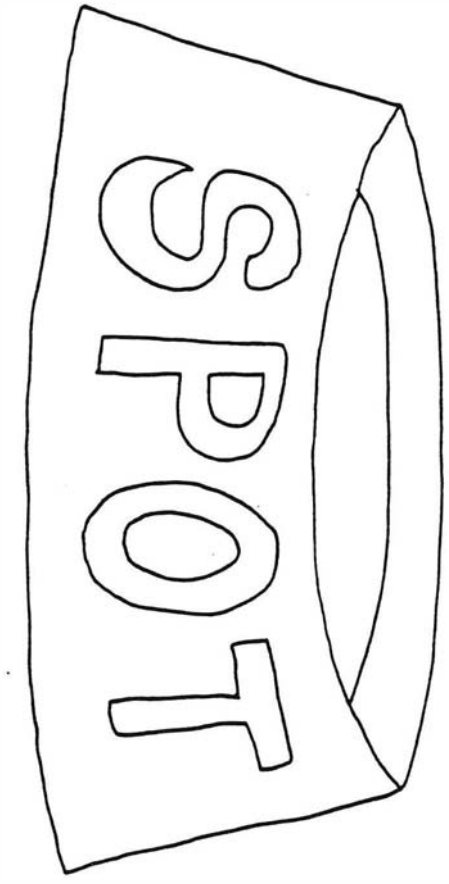

RYE
FLOUR
XXX

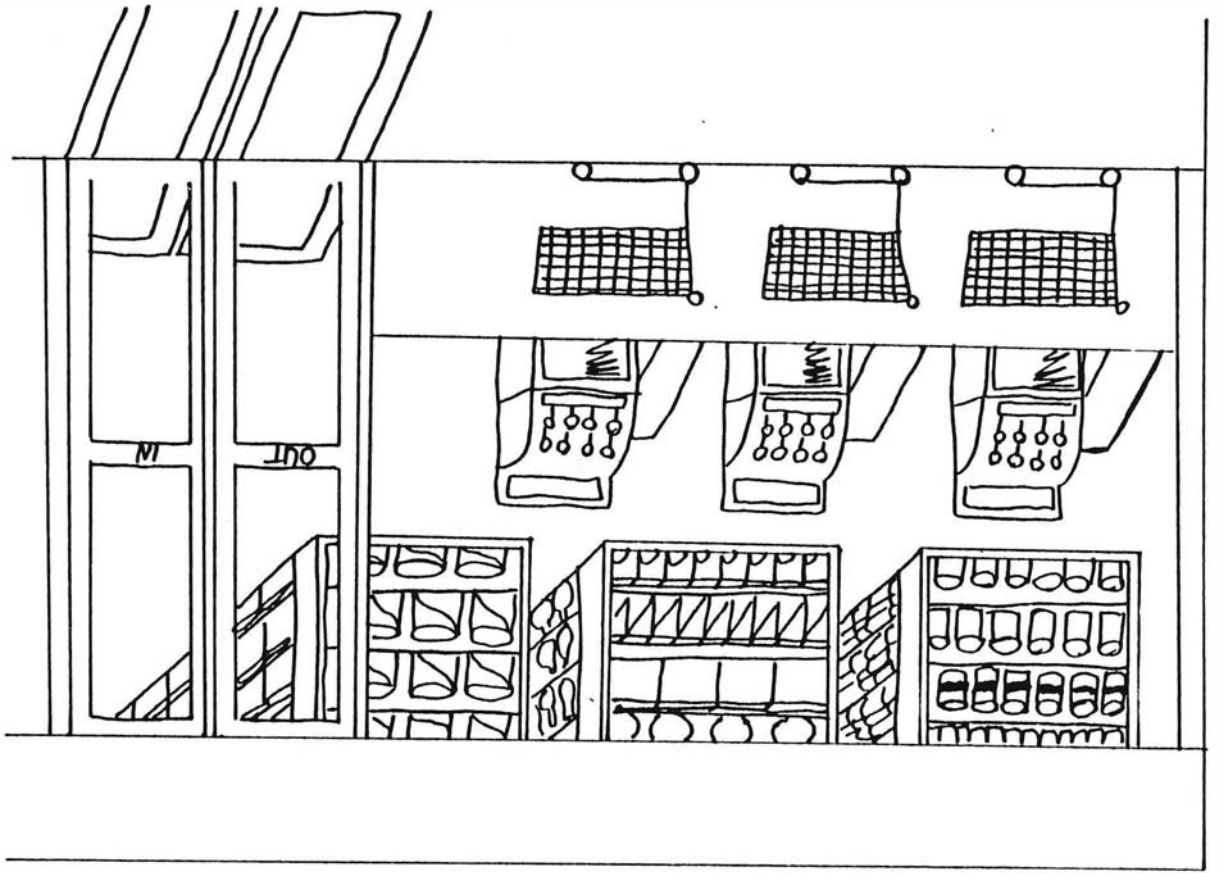


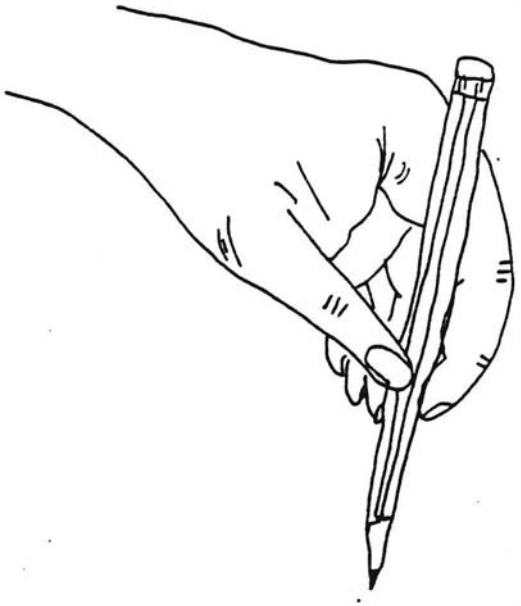


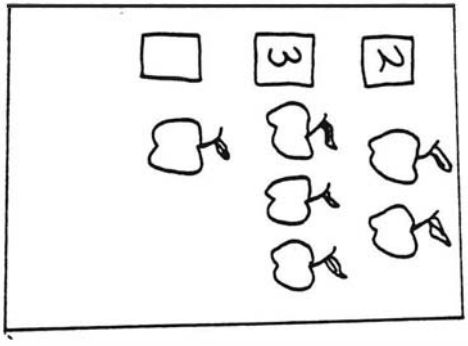
Sweetarts
TANGY CANDY
ASSORTED FLAVORS
Sweetarts
TANGY CANDY
ASSORTED FLAVORS
Sweetarts
TANGY CANDY
ASSOR
S

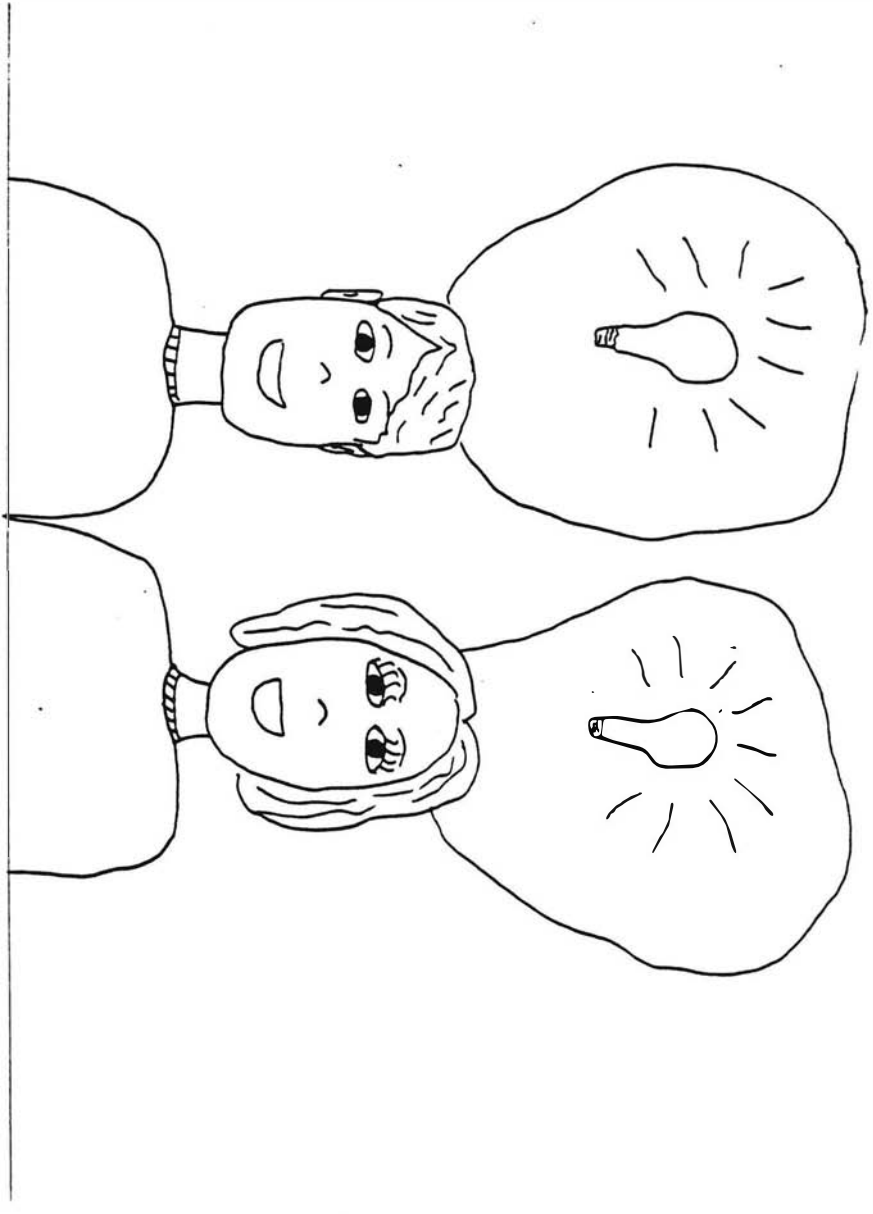


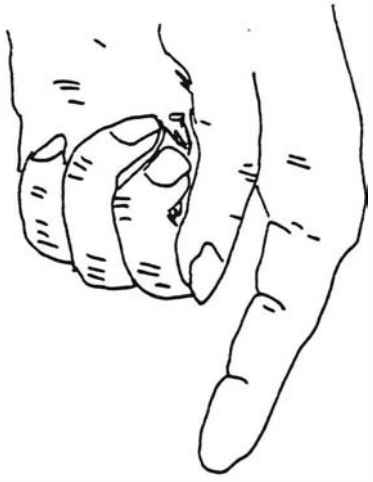

SPOT

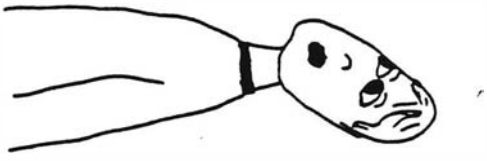

IN
OUT

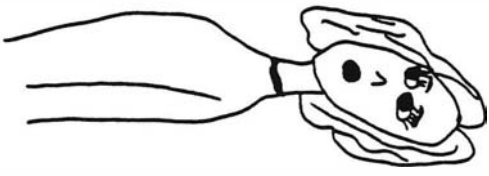


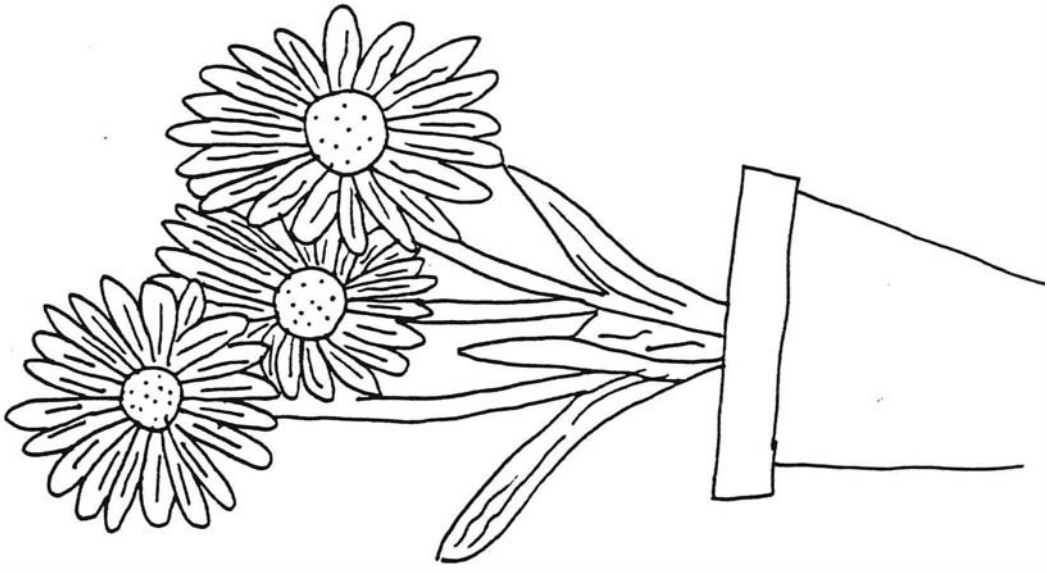

2
3

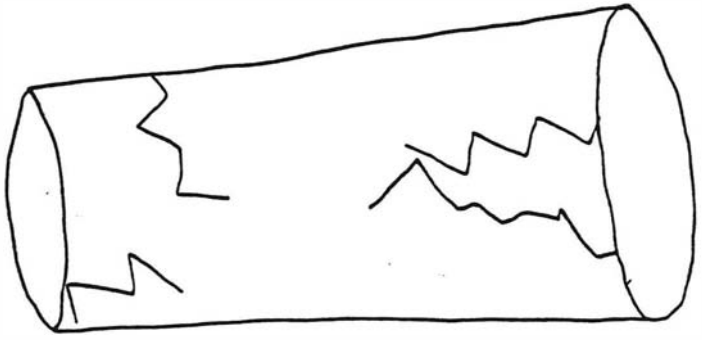


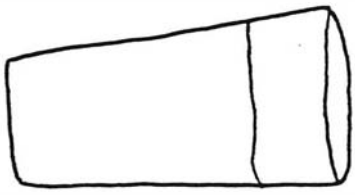


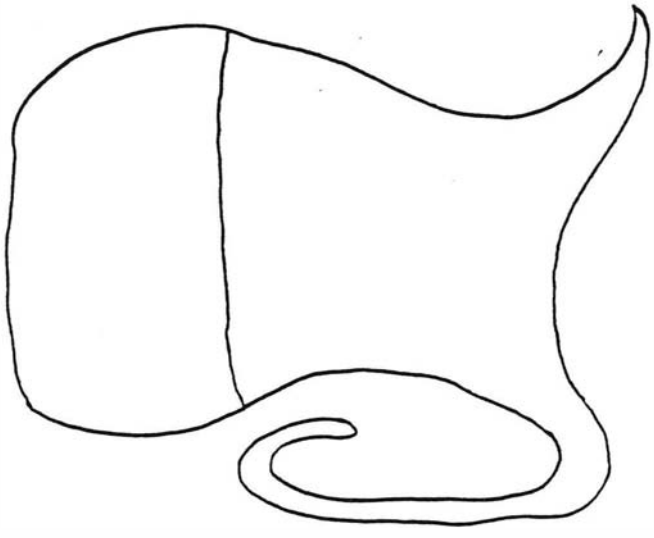


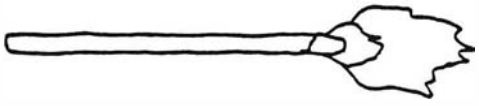


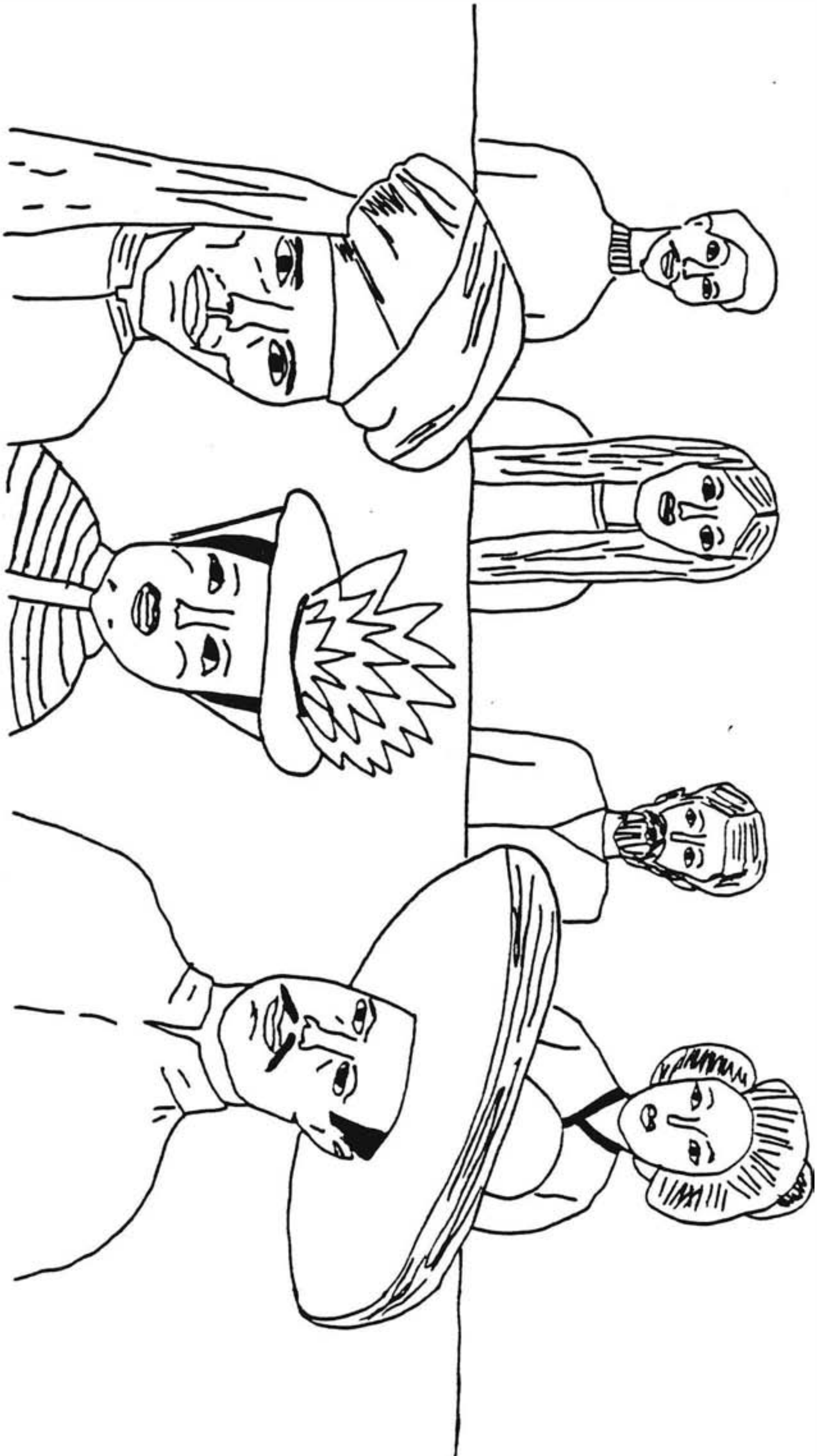


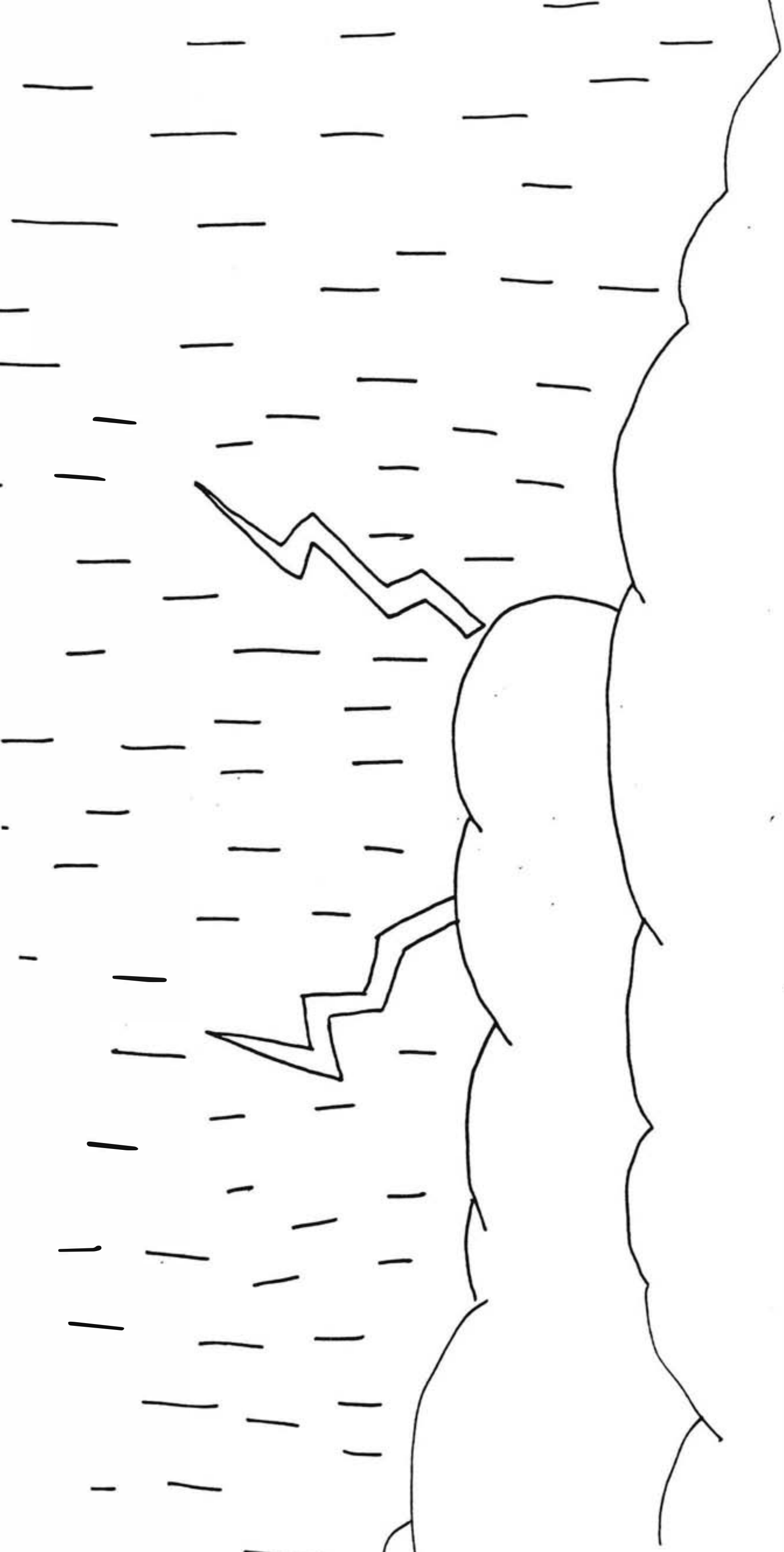


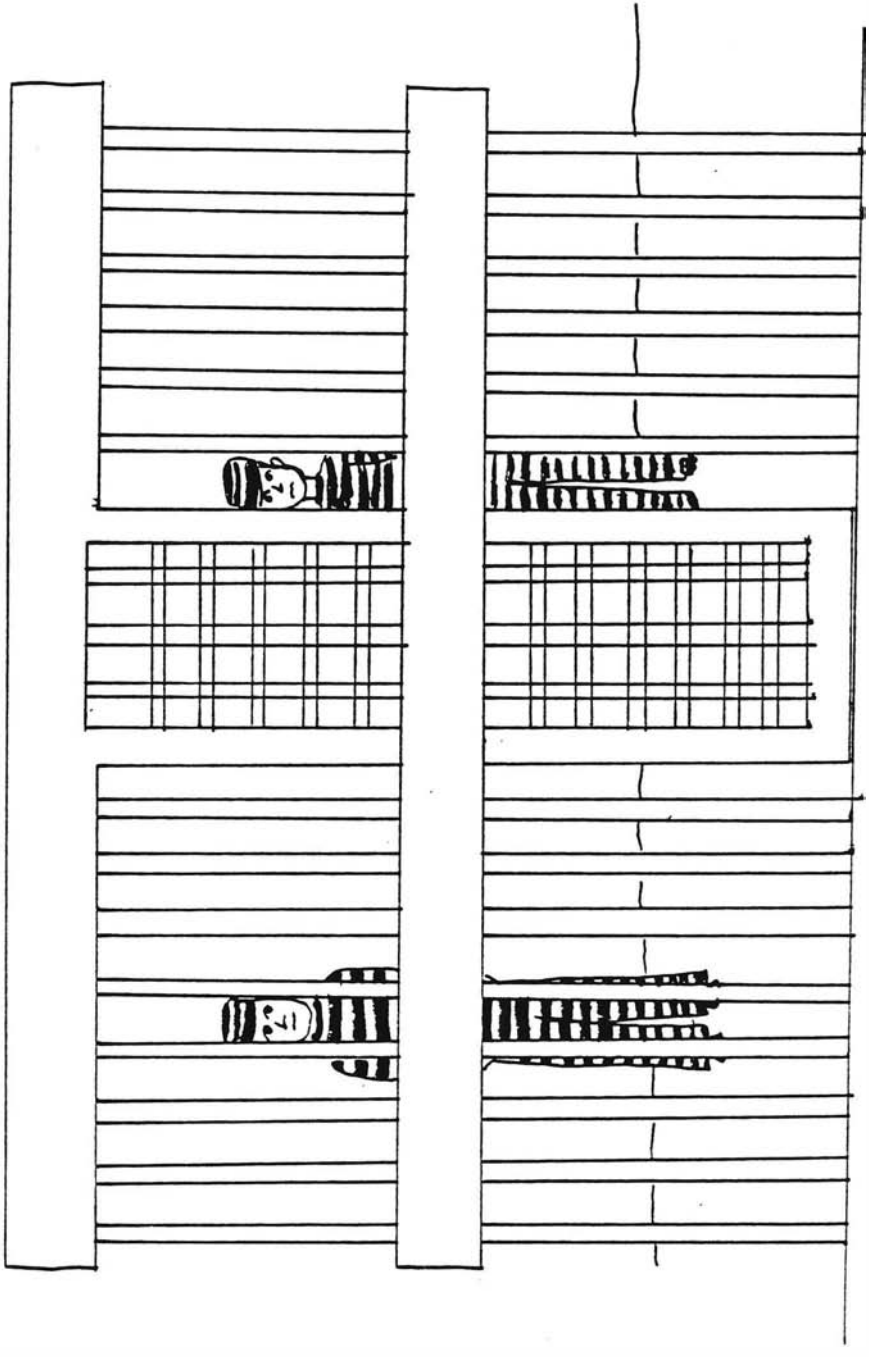


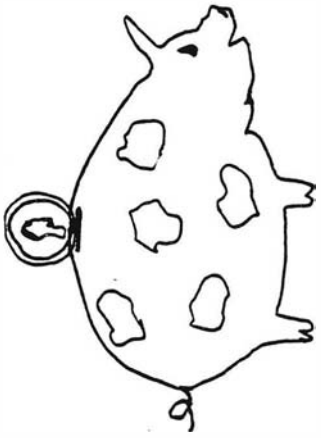


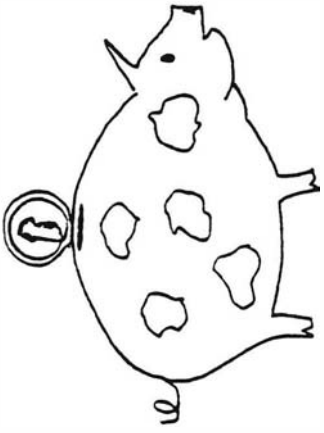


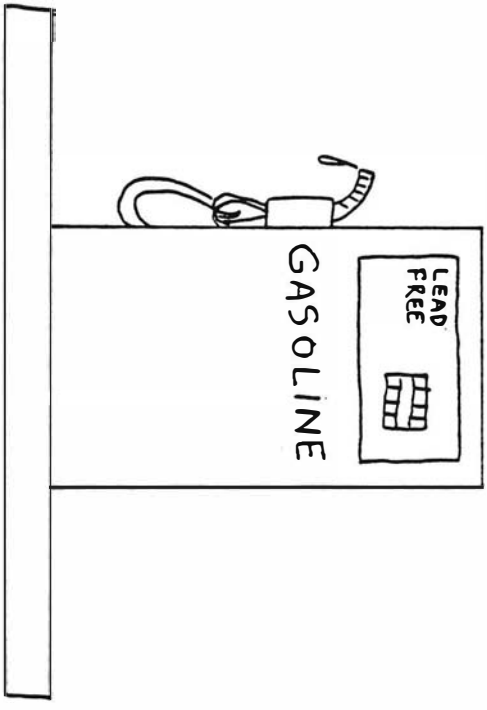











LEAD
FREE
GASOLINE

Appendix 9

Order and Location of Picture Presentations

Item on Tape	Pictures Presented	
1. people	a name	an aim
	sweetheart	sweet tart
	people	gasoline
2. banks	writer	rider
	may cry	make rye
	daisies	banks
3. sweet tart	bad weather	people
	market	mark it
	sweetheart	sweet tart
4. market	market	mark it
	a name	an aim
	daisies	match
5. gasoline	writer	rider
	both thought	both ought
	cracks in the glass	gasoline
6. writer	drink	match
	writer	rider
	market	mark it
7. a name	an aim	a name
	market	mark it
	bad weather	daisies
8. both thought	match	drink
	sweetheart	sweet tart
	both thought	both ought
9. cracks in the glass	a name	an aim
	market	mark it
	bad weather	daisies
10. market	mark it	market
	people	daisies
	make rye	may cry
11. bad weather	bad weather	prisoners
	make rye	may cry
	both ought	both thought

12. sweet tart	sweet tart	sweetheart
	bad weather	people
	market	mark it
13. may cry	a name	an aim
	prisoners	banks
	make rye	may cry
14. both ought	both ought	both thought
	sweet tart	sweetheart
	match	drink
15. rider	drink	match
	writer	rider
	mark it	market
16. a name	bad weather	gasoline
	market	mark it
	a name	an aim
17. gasoline	gasoline	people
	make rye	may cry
	an aim	a name
18. make rye	make rye	may cry
	daisies	cracks in the glass
	both ought	both thought
19. mark it	sweetheart	sweet tart
	prisoners	drink
	mark it	market
20. daisies	banks	daisies
	both thought	both ought
	writer	rider
21. an aim	make rye	may cry
	a name	an aim
	match	cracks in the glass
22. both ought	both ought	both thought
	writer	rider
	drink	match
23. match	both ought	both thought
	writer	rider
	drink	match
24. writer	make rye	may cry
	prisoners	people

	rider	writer
25. sweetheart	sweetheart daisies both thought	sweet tart prisoners both ought
26. may cry	market may cry banks	mark it make rye match
27. an aim	cracks in the glass mark it an aim	bad weather market a name
28. mark it	banks writer may cry	drink rider make rye
29. both thought	market people both thought	mark it cracks in the glass both ought
30. rider	bad weather writer may cry	gasoline rider make rye
31. sweetheart	writer people sweet tart	rider bad weather sweetheart
32. make rye	market make rye gasoline	mark it may cry prisoners
33. people	make rye people writer	may cry match rider
34. prisoners	sweet tart rider people	sweetheart writer prisoners
35. banks	rider market banks	writer mark it match
36. drink	mark it an aim drink	market a name gasoline

Appendix 10

Phonetic Ambiguity Response Sheet

#	Item	Child's Repetition	Meaning	Picture Chosen
1.	people			
2.	banks			
3.	sweet tart			
4.	market			
5.	gasoline			
6.	writer			
7.	a name			
8.	both thought			
9.	cracks in the glass			
10.	market			
11.	bad weather			
12.	sweet tart			
13.	may cry			
14.	both ought			
15.	rider			
16.	a name			
17.	gasoline			
18.	make rye			
19.	mark it			
20.	daisies			

#	Item	Child's Repetition	Meaning	Picture Chosen
21.	an aim			
22.	both ought			
23.	match			
24.	writer			
25.	sweetheart			
26.	may cry			
27.	an aim			
28.	mark it			
29.	both thought			
30.	rider			
31.	sweetheart			
32.	make rye			
33.	people			
34.	prisoners			
35.	banks			
36.	drink			

Appendix 11

Table 12

Item Analysis of the Percentage and Number of Subjects Responding Correctly

Item	Children %(#)		Adults %(#)	
	No	Prim	No	Prim
1.	81.25(13)	75.00(12)	100.00(21)	100.00(12)
2.	56.25(9)	50.00(8)	95.24(20)	91.67(11)
3.(R)	75.00(12)	87.50(14)	90.48(19)	91.67(11)
4.(F)	68.75(11)	100.00(16)	80.95(17)	66.67(8)
5.	81.25(13)	93.75(15)	95.24(20)	100.00(12)
6.(F)	62.50(10)	93.75(15)	95.24(20)	41.67(5)
7.(F)	62.50(10)	81.25(13)	61.90(13)	75.00(9)
8.(F)	.00(0)	50.00(8)	47.62(10)	58.33(7)
9.	93.75(15)	100.00(16)	85.71(18)	100.00(12)
10.(F)	75.00(12)	93.75(15)	80.95(17)	58.33(7)
11.	81.25(13)	93.75(15)	100.00(21)	100.00(12)
12.(R)	62.50(10)	81.25(13)	85.71(18)	91.67(11)
13.(F)	81.25(13)	93.75(15)	95.24(20)	91.67(11)
14.(R)	.00(0)	6.25(1)	9.52(2)	58.33(7)
15.(R)	25.00(4)	37.50(6)	42.86(9)	83.33(10)
16.(F)	56.25(9)	87.50(14)	57.14(12)	58.33(7)
17.	81.25(13)	87.50(14)	95.24(20)	100.00(12)
18.(R)	31.25(5)	50.00(8)	28.57(6)	100.00(12)
19.(R)	12.50(2)	6.25(1)	14.29(3)	41.67(5)
20.	87.50(14)	87.50(14)	100.00(21)	100.00(12)
21.(R)	12.50(2)	12.50(2)	.00(0)	50.00(6)
22.(R)	.00(0)	.00(0)	23.81(5)	66.67(8)
23.	93.75(15)	87.50(14)	100.00(21)	100.00(12)
24.(F)	75.00(12)	100.00(16)	52.38(11)	50.00(6)
25.(F)	68.75(11)	75.00(12)	100.00(21)	100.00(12)
26.(F)	93.75(15)	93.75(15)	100.00(21)	100.00(12)
27.(R)	12.50(2)	6.25(1)	.00(0)	16.67(2)
28.(R)	12.50(2)	.00(0)	28.57(6)	33.33(4)
29.(F)	.00(0)	.00(0)	42.86(9)	75.00(9)
30.(R)	25.00(4)	18.75(3)	66.67(14)	91.67(11)
31.(F)	68.57(11)	81.25(13)	100.00(21)	100.00(12)
32.(R)	25.00(4)	31.25(5)	57.14(12)	100.00(12)
33.	93.75(15)	87.50(14)	100.00(21)	83.33(10)
34.	81.25(14)	100.00(16)	100.00(21)	100.00(12)
35.	62.50(10)	68.75(11)	47.62(10)	91.67(11)
36.	100.00(16)	100.00(16)	100.00(21)	100.00(12)

[a] Note. Underlined items are phonetic ambiguity pair members; "R" denotes a rare member, "F" denotes a frequent member.

Table 13

Item Analysis of the Percentage and Number of Subjects Responding with the Other Member During Presentations of Phonetic Ambiguities

Item	Children %(#)		Adults %(#)	
	No	Prim	No	Prim
3.(R)	18.75(3)	6.25(1)	9.52(2)	8.33(1)
4.(F)	18.75(3)	.00(0)	9.52(2)	33.33(4)
6.(F)	31.25(5)	6.25(1)	4.76(1)	58.33(7)
7.(F)	.00(0)	12.50(2)	.00(0)	.00(0)
8.(F)	.00(0)	12.50(2)	.00(0)	16.67(2)
10.(F)	12.50(2)	6.25(1)	14.29(3)	41.67(5)
12.(R)	25.00(4)	18.75(3)	14.29(3)	8.33(1)
13.(F)	6.25(1)	56.25(9)	.00(0)	.00(0)
14.(R)	62.50(10)	62.50(10)	28.57(6)	25.00(3)
15.(R)	18.57(3)	6.25(1)	53.38(11)	16.67(2)
16.(F)	.00(0)	.00(0)	.00(0)	16.67(2)
18.(R)	43.75(7)	50.00(8)	4.76(1)	.00(0)
19.(R)	81.25(13)	93.75(15)	85.71(18)	58.33(17)
21.(R)	68.75(11)	81.25(3)	47.62(10)	41.67(15)
22.(R)	.00(0)	62.50(10)	19.05(4)	8.33(1)
24.(F)	18.75(3)	.00(0)	4.76(1)	.00(0)
25.(F)	31.25(5)	25.00(4)	.00(0)	.00(0)
26.(F)	.00(0)	.00(0)	.00(0)	.00(0)
27.(R)	68.75(11)	87.50(14)	52.38(11)	58.33(7)
28.(R)	75.00(12)	100.00(16)	61.90(13)	66.67(8)
29.(F)	.00(0)	.00(0)	.00(0)	.00(0)
30.(R)	68.75(11)	81.25(13)	33.33(7)	8.33(1)
31.(F)	31.25(5)	18.75(3)	.00(0)	.00(0)
32.(R)	62.50(10)	62.50(10)	42.86(9)	.00(0)

Note. "F" denotes a frequent member; "R" denotes a rare member.

Appendix 12

Figure 1

Mean Number Correct(Priming x Word Form):

Childrens Data

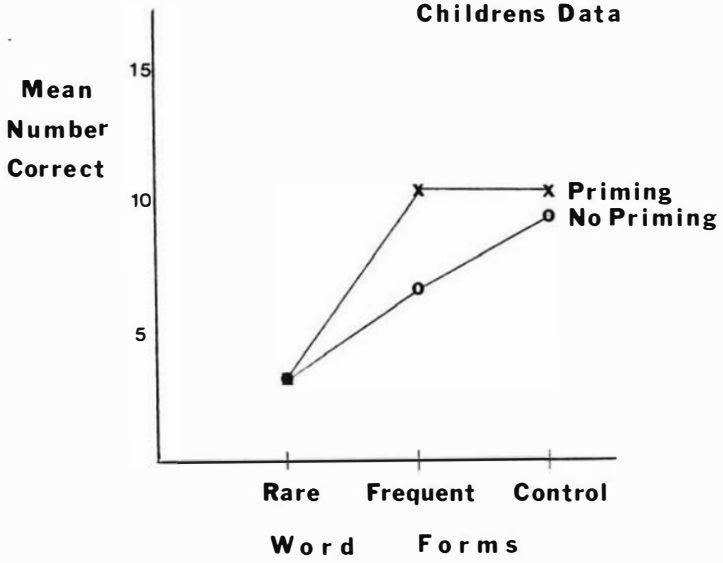


Figure 2

Adults Mean Number Correct(Priming x Word Form)

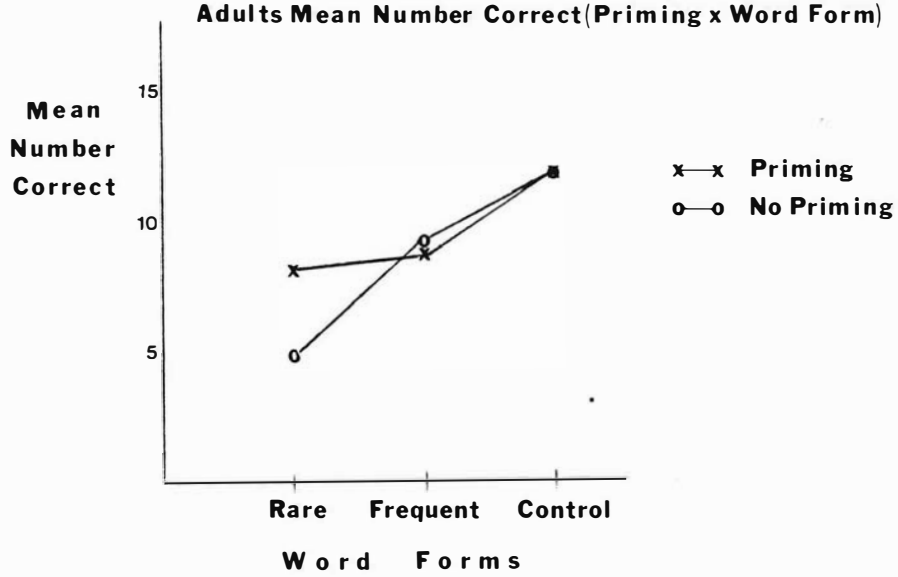
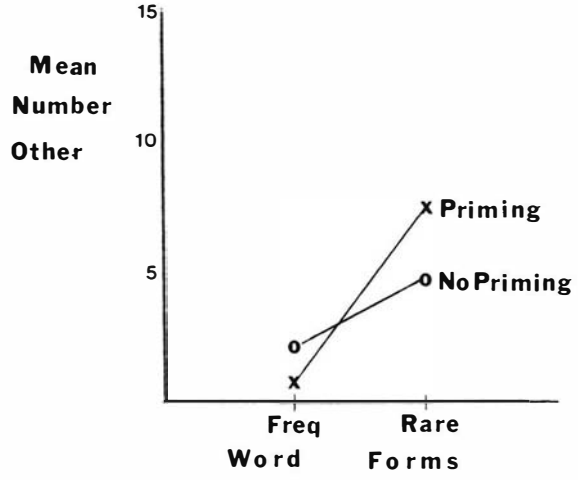


Figure 3

Childrens Mean Number Other (Priming x Word Form)



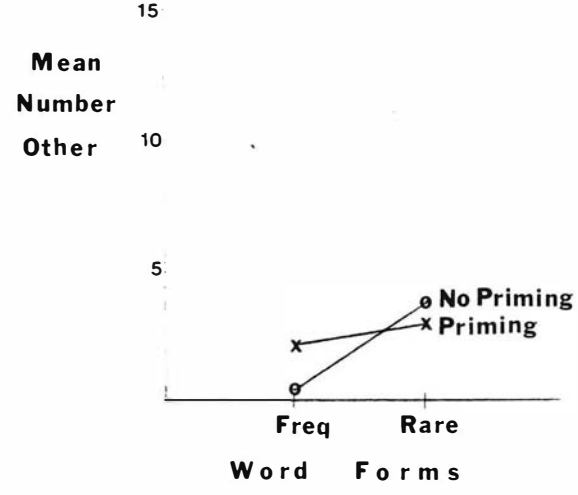


Figure 4

Adults Mean Number Other (Priming x Word Form)

Vita