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Phonetic Ambiguity Perception in Reading Disabled and Non-disabled Children and Adolescents

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Phonetic Ambiguity Perception in Reading Disabled and Non-Disabled Children and Adolescents

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Abstract

Title of Thesis: PHONETIC AMBIGUITY PERCEPTION IN READING DISABLED AND NON-DISABLED CHILDREN AND ADOLESCENTS

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There are speculations that disabled readers may fail to correctly decode written words because they are insensitive to language's phonetic form. This insensitivity is presumed by some to be due to a speech perceptual deficit. The purpose of the current study was to assess differences between disabled and non-disabled adolescents and elementary school students in their perceptual accuracy in decoding phonetically ambiguous speech. The effects of two processing factors derived from previous research, priming and word form (e.g., Spencer & Carter, 1982), were also examined to assess how perceptual processes may differ between groups. Clinical evidence of some verbal problems persisting in adolescent disabled populations and evidence of compensatory differences between elementary and adolescent readers on earlier phonetic coding tasks prompted the inclusion of all four age group by reading group combinations. Results reveal no reading group differences of either age grouping. The results are discussed in terms of design considerations, previous pertinent speech perception research, and similarity of responses to those of normal subjects in Spencer and Carter (1982) and Carter and Zoller (1983). With an examination of two dependent measures and a qualitative analysis of errors, no reading group differences were found. Therefore, it is suggested that explanations involving speech

perception may not appropriately address the problems of disabled readers with problems in word decoding.

Phonetic Ambiguity Perception in Reading Disabled and Non-Disabled Children and Adolescents

The failure of some students to develop reading skills commensurate with their age, average or above average intelligence, socioeconomic status, and quality of general education has stimulated increasing interest in recent years (Ellis, 1984; I. Taylor & M. Taylor, 1983; Vellutino, 1978, 1979). These students are often referred to as _specifically disabled_, _dyslexic_, or _reading disabled_ (RD) (Olson, Kliegl, Davidson, & Foltz, 1985). With respect to their reading behaviors, RD students have been described by teachers and researchers as having unusual difficulty in identifying words as wholes, as well as segmenting them into their component sounds. They have demonstrated difficulty in abstracting and generalizing the common constituents of given words, and they have failed to recognize common sounds across words (_fat_, _cat_, _bat_). Further, these students have tended to be poor spellers, and their written language has been judged to be deficient in all respects (Ellis, 1984; Vellutino, 1979).

Verbal Deficit: An Overview

Taking into account the difficulties that these students face when dealing with linguistic material, a group of theorists have speculated that many disabled readers may have deficiencies in both long- and short-term memory (LTM, STM), characterized as either a paucity of or inaccessibility to various types of verbal information. These authors have reasoned that a rich fund of semantic, syntatic, and phonetic information, derived from experience with language prior to and concurrent with experience in reading, provides the normal student with a broad variety of implicit mnemonics as well as a variety of contexts. They have contended that being able to tap into such resources allows the student to easily symbolize or code stimulus input for efficient processing. Further, these authors have speculated that any student who lacks such resources would be especially encumbered when presented with short-term memory tasks which require rapid coding of verbal information for effective rehearsal and retrieval, such as that required in the reading process. This position has been termed the verbal deficit or verbal processing inefficiency hypothesis (Ellis, 1984; Siegel, 1985; Vellutino, 1978, 1979).

Unfortunately, to date, there have been few programmatic assessments of how RD students deal with language, either written or spoken; the majority of the research is fragmented (Bryan, 1979; Siegel, 1985). There are few studies which have explored specific verbal processing differences between RD and non-disabled (NRD) students. Yet, there are at least some investigations representing each of the following linguistic levels: semantic, syntactic, and phonetic. For example, researchers have assessed semantic skills variously according to story-telling ability (Fry, Johnson, & Muehl, 1970), sensitivity to the meaning and structural attributes of sentences (Waller, 1976), and speed in providing the correct names of common objects, colors, letters, and digits (Denckla & Rudel, 1976). Collectively, these findings have been interpreted as indicating that the RD and NRD students do not significantly differ in understanding the general meanings conveyed by words and sentences. However, they do differ in retaining subtleties (i.e., tense and number).

Investigators have also examined reading group differences in syntactic skills using a variety of methods. For example, Weinstein and Rabinovitch (1971) required RD and NRD students to remember syntactically structured and randomly structured combinations of words and nonwords. NRD students recalled the syntactically structured combinations better than the unstructured strings, which implies that NRD students are sensitive to the syntactic structure of sentences. This difference was not obtained for RD students. Siegel and Ryan (1984) required students to fill in the missing word in sentences read to them. Examples include: "It _ very cold outside." "Jack _ his sister ran up the hill." RD students provided more unacceptable words than did NRD counterparts. Wiig, Semel, and Crouse (1973) presented RD and NRD children with a task in which they had to supply the correct inflection for nonwords. The children were presented with nonsense figures and told, for example. "This is a gak. Now here is another one. There are two of them. There are two _ ." The RD students made significantly more errors than did the NRD students. The specific problems they evidenced were difficulties with possessives, inflections, and auxiliary verbs.

The results of these and similar studies comparing RD and NRD students on different measures of syntax and semantics have helped provide tentative empirical support for the contention that deficiencies or inefficiencies in verbal processing may be related to reading disabilities (Siegel, 1985).

Phonetic coding is the transduction of speech sound into a form which is amenable to cognitive processing. Two separate conceptual frameworks have evolved which deal with phonetic-level linguistic processing. The older view, originally proposed by Wepman (1960), is that many RD students are impaired in their "auditory discrimination" of speech sounds. Wepman has characterized some RD students as being unable to perceive phonemic differences--differences in the sounds of speech which indicate differences in meaning within the particular language spoken. Results of research evaluating this position have been mixed, probably due to methodological inconsistencies. But, the idea has received widespread acceptance in clinical and educational circles (Bryan, 1979; Lerner, 1981).

More recently, several theorists have advanced a slightly different position (Downing, 1973; Elkonin, 1973; I. Liberman & Shankweiler, 1978; Mattingly, 1972; Savin, 1972). Without making reference to perceptual differences between reading groups, per se, these authors contend that some RD children may be deficient in the degree to which they are aware that speech is made up of phonemes. Such knowledge is necessary if the student is to relate letters (and letter combinations) to corresponding speech sounds. These authors have speculated that this lack of awareness is primarily due to weak phonetic coding. The RD student's representation of sound relatively incomplete, and/or it may be the case that they fail to use phonetic coding when appropriate. Some reading comprehension theorists have also used reading group differences in phonetic coding to explain some of the problems that RD students face when required to recall phrases and sentences verbatim (e.g., Bryne, 1981; Perfetti & Lesgold, 1978; Satz, Taylor, Friel, & Fletcher, 1978).

Although the spelling-sound and reading comprehension theorists invoke phonetic coding differences to help explain group differences in reading performance, most have not elaborated as to what may underlie the weak coding.

A Preliminary Explanation

Despite the somewhat disjointed nature of the literature, one can gather that there is considerable support for the idea of a relationship between language problems and reading disabilities. For example, as will be shown in the literature review, there are predictive and retroactive assessments and clinical and anecdotal reports which record RD students' problems acquiring basic oral language skills. Such sources also report that these difficulties persist, in a milder form, into adolescence.

Specifically related to the present investigation are several studies, elaborated on in the literature review, which have demonstrated that RD students, as a group, are deficient in their ability to analytically deal with the sounds of spoken language. For example, in addition to the many reports of reading group differences in acquiring SSC rules (e.g., Calfee, 1982; Siegel, 1985), there is evidence of RD students having greater difficulty than NRD age-mates in segmenting words into phonemes (e.g., Liberman Shankweiler, Fischer, & B. Carter, 1974). There also are consistent findings of young and adult NRD subjects strongly relying on phonetic coding in memory for lists of verbal stimuli, while young RD students are found to not do so (e.g., Conrad, 1964; Mann, Liberman, & Shankweiler, 1980). As an explanation of such results several theorists have reasoned that the student cannot be expected to establish correct mental representations of the sounds of speech if he or she does not correctly decipher those sounds in the first place (Brady, Shankweiler & Mann, 1983; Perfetti & Lesgold, 1978). This idea, which evolved primarily from work in the SCC framework, is clearly in concert with the verbal deficit/inefficiency perspective and harks back to Wepman's earlier speculations. If this idea is correct, there should be empirical substantiation.

The "How" Issue

Unfortunately, the speech perception research with RD subjects is anemic. As will be seen, findings within Wepman's framework, though relatively numerous, are often inconsistent. This makes firm conclusions dubious. The other available research (Brady et al.: 1983; Godfrey, Syrdal-Lasky, Millay, & Knox, 1981), demonstrates some reading group differences. While this is encouraging, there are only two studies, and replication is needed. Yet, even continued findings of RD students differing from NRD students, alone, would provide only a partial picture of the possible differences in speech perception between these groups. Clearly, there is a need for investigation into how the perceptual processes of the two groups might differ, as well. Based upon two factors found to significantly influence phonetic ambiguity perception, the present study provides an attempt at such inquiry.

The general reasoning for the present study takes into consideration the following. In an environment such as a classroom, the listener must routinely deal with a continuous stream of speech. (The stimuli used in the current study are from samples of continuous speech.) It is known that natural, conversational speech is largely ambiguous (e.g., Cole, 1979). Because of this, it cannot be presumed that there is a "straight" transduction from signal to percept. So, how can listeners disambiguate speech? The listener must be contributing information--making perceptual inferences--based upon previous knowledge of the structure of language, expectations of what speakers typically do, etc. (Fodor, 1983, 1985). The current focus, of course, is on perception of phonetic level information. Thus, uncovering information about how disabled readers disambiguate phonetic ambiguities should be a start in answering how their perceptual processing may differ from that of non-disabled students.

Answering the How Question--Two Factors: A Beginning

Based upon work with phonetic ambiguity perception in non-disabled adults and preliterate preschoolers (Spencer & Wollman, 1980; Spencer & Carter, 1982; Carter & Zoller, 1983), these researchers have found evidence of two types of information--two factors which can come into play when listeners are faced with a task of trying to identify phonetic ambiguities. First, within a phonetic ambiguity pair (e.g., sweetheart/sweet tart), the listeners strongly tended to perceive one member more often than the other, regardless of which of the two was presented. This is known as the word form effect. Further, when subjects were shown the phonetic ambiguity pairs prior to testing (i.e., are pre-informed or "primed") correct identification vastly improved. It appears that the ability of young and adult listeners to correctly recognize speech that is anything but veridical is strongly facilitated by these two factors. Therefore, the present study will attempt to answer the "how" question by exploring the effects of these two factors on the speech perception of RD and NRD students.

Literature Review

According to Benton's (1975) review of the reading disabilities literature, the belief that reading disabilities may be related to underlying language problems dates back to McCready (1910) and Bronner (1917). Both authors make note of the high frequency with which their "backward readers" showed signs of delayed language acquisition. Clinical observations over the years suggest further support for this idea.

A sample of clinical reports spanning a 40 year period reveals that between 50 and 100% of elementary school students whom the authors classified as "backward" or "poor" readers evidenced a history of language problems. These problems included: slowed speech development, poor vocabulary relative to age and intelligence, immature definitions of known words, and persistent use of simple grammar structure (Ingram & Reid, 1956; Lyle, 1970; Lyle & Goye, 1969; Monroe, 1932; Warrington, 1967). Along with these investigations, two predictive studies have been widely cited as tentative evidence of a language problem-reading disabilities link (Ellis, 1984; Lerner, 1981; I. Taylor & M. Taylor, 1983; Vellutino, 1978, 1979). De Hirsh, Jansky, and Langford (1966) report that their diagnosed language disordered kindergarten children (non-readers) were diagnoseable as reading disabled by the time they reached the second grade. Results were replicated by Jansky & de Hirsh 1972).

Also, there is more recent evidence that linguistic problems, such as those mentioned previously, may persist in a more subtle form into adolescence (e.g., King, Jones, & Lasky, 1982; Maxwell & Wallach, 1984; Wiig & Semel, 1980) and, perhaps, into adulthood (Hasbrouck, 1983; King et al., 1982). For example, in their recent review of the literature relevant to a language-learning disablities connection, Maxwell et al. (1984) cite an interesting paper by Strominger and Bashir (1977). Strominger and Bashir (1977) extended the work of de Hirsh et al. (1966) and Jansky et al. (1972). They conducted a follow-up study which asked whether children who are recognized early as having language disablities also experience reading, writing and spelling problems as they get older. Strominger et al. examined the clinical records of 40 children who had been seen in their clinic before the age of 5 years. These children had been diagnosed as having "delayed language," including vocabulary and syntactic problems and unintelligible speech (for some). The children were seen again at ages 9 and 11 years. In the interim between initial intake and the reassessment, none of the children had been diagnosed as mentally retarded, severely emotionally impaired, or motorically impaired. Out of the 40 children assessed in the later ages, 38 were diagnoseable as reading disabled (i.e., reading age below chronological age). They manifested problems with spelling and written expression and had mild problems with oral reading tasks, also, though their oral expression was not impaired to the same degree as it was previously.

In a similar vein, King et al. (1982) examined language skills in a formerly diagnosed, language-impaired population. Their subjects were older than those in the Strominger et al. (1977) study. Fifty subjects ranged in age from 13 years 10 months to 20 years 5 months. At initial intake all of the subjects had been under age 5. Rather than examine school records and administer reading tests, King et al. sent questionaires to family members to gain information concerning the subjects' communication, social, academic, and occupational outcomes. The responses indicated that 42% of the subjects were perceived by family members as having communication problems. The authors describe the typical subject as having "trouble finding words and expressing himself," as not being able to "understand complicated directions," and as having "difficulty in pronouncing some combination of sounds" (King et al., 1982, p. 30). School problems were evidenced by delayed admissions, the need for tutors, repeated grades, and special placements.

Anecdotal support for the idea that language problems may persist past childhood comes from a study by Wiig and Semel (1980). From self-reports, Wiig et al. (1980) have surmised that the specific language deficits that adults and young adolescents experienced as children tend to re-emerge when they are faced with unexpected demands, such as those involved in a new area of study, a new job, or a promotion. Also, Hasbrouck (1983) conducted a study with adult subjects. They ranged in age from 18.8 to 58.3 years and were referred to speech/language therapists as adults because of difficulties with written expression and spelling. Hasbrouck reported that these adults had problems with auditory discrimination measures which had been designed, originally, for use with young pupils. Unfortunately, it is impossible to tell from the report whether the subjects' problems became evident only in adulthood, whether they were present when the subjects were children (yet went undiagnosed), or whether there was some mixed bag of these conditions. Thus, conclusions based upon this study must be constrained, accordingly.

Despite the design problems inherent in anecdotal reports and one-shot clinical observations, these studies in addition to the follow-up investigations have lent support for the idea that there is a relationship between language disorders and reading-related problems and that the difficulties RD adolescents experienced with spoken language as youngsters may re-emerge at times.

Although the following studies did not use RD subjects, their results are consistent with the position that experience with spoken language is related to reading ability. These investigations employed deaf subjects. Within these studies, congenitally, profoundly deaf (CPD) children have been reported, consistently, to have greater difficulty than hearing children in learning how to read (Frumkin & Anisfeld, 1977; Gibson, Shardiff, & Yonas, 1970; Swisher, 1976). More specifically to the point of cognitive representation, studies have indicated differences in hearing and CPD subjects. For example, given the CPD child's lack of access to speech sounds, Conrad (1971, 1972) reasoned that such deaf subjects would use a non-phonetic code to retain linguistic stimuli. He had CPD children and adults immediately recall visually presented letters. His results indicated that the CPD, especially those who have poorly developed speech skill, use the visual properties of the letters to code them for immediate recall. In a subsequent study, Bellugi, Klima, and Siple (1975) examined the influence of the formational aspects of American Sign Language (ASL) on the recall of hearing and deaf students. They wanted to determine if the CPD visually code linguistic input other than that expressed through writing. Immediately after presentation, their subjects were required to write the English equivalents of the ASL items. The types of errors made by each group differed and this difference denoted differences in coding. The deaf group made errors similar in manual formation to the target, while the hearing subjects made errors which were phonemically similar. Considering the results of these studies, Conrad (1979) concluded that due to the lack of precise phonemic coding as a base, the CPD are likely to use a visuo-spatial code, instead, when processing linguistic material.

What must be noted, however, is that there have been findings which appear to be contradictory to those above. These results have indicated, surprisingly, that some deaf students may be able to derive and use a speech-based code. Studies done with CPD subjects who have been trained to lip-read have shown that they have made word recall errors which were phonemically similar to the targets (Oller & Kelly, 1974; Dodd, 1976; Vogel, 1976), that they have matched written homophones (i.e., words which sound the same), and that they have identified pairs of lip-read nonsense words as rhyming (Dodd & Hermelin, 1977), and that they have written down lip-read nonsense words (Dodd, 1980).

In an effort to explain these incongruous results, Dodd, Brasher, and Campbell (1983) have offered the possibility that lip-read information may, somehow, lend itself to pseudo-phonetic coding. The movements of lips and tongue have direct impact on the way speech sounds are produced. These researchers have explained that this possible coding form does not involve the sound of spoken language, per se, but a representation of the articulatory movements which would be required to make those sounds. These authors have speculated that training in the oral tradition allows the deaf student to make visual associations with the written word and the cognitive representation of the articulatory movements used to speak the word. They have posited that without training in lip-reading, this form of language representation is probably not readily available to other CPD students. Therefore, because many deaf students do not know how to lip-read when they come to school (and some never learn) (Campbell & Dodd, 1983), their reliance on any form of speech coding would not be expected to be substantial. The above authors who reported poor reading skill and lack of phonetic coding in their CPD subjects did not specify if their deaf subjects were lip-readers or not. Thus, it is feasible that such studies may have had samples composed mostly of non-lip-readers. In order to clear the issue, the performance of lip-readers and non-lip-readers must be compared under the same conditions. Unfortunately, this remains to be done. However, even without this direct empirical validation, the Dodd et al. (1983) speculations are conceptually sound and consonant with the tenets of the verbal processing deficit/inefficiency hypothesis.

The support provided by the clinical observations, anecdotal reports, predictive and retroactive research, and a number of comparisons between CPD and hearing subjects has served to empirically bolster the idea of a link between the coding involved with language and that involved with reading. In addition to the studies which follow, such support provided impetus to the development of phonetic-level research in the realm of reading disabilities. As touched on earlier, this resulted in two conceptual frameworks. The older view characterizes many RD students as having problems with the perceptual auditory discrimination of speech sounds. The more recent avenue focuses on the student's awareness of the phonetic structure of language. What follows is a review of both literatures and their relation to phonetic ambiguity perception.

Auditory Discrimination

The most popular explanation with clinicians, especially, and the most investigated explanation implicating auditory processing deficit is that proposed by Wepman (1958, 1960, 1961) (Bryan, 1979; Harber, 1980; Lerner, 1981; Vellutino, 1979). Wepman has advanced the hypothesis that the ability to discriminate between speech sounds is intimately related to competency in the linguistic skills of speaking, reading, spelling, and writing. He has put forward the idea that such highly conceptualized linguistic behavior is dependent upon, but not guaranteed by, more elementary, perceptual capacities. He has speculated further that the failure to adequately develop such abilities is evidenced in the difficulties faced by language disordered and RD students. Accordingly, he proposed that knowledge of a student's auditory phonemic discrimination ability should be an important factor in predicting his or her level of reading ability.

Thus, to test his theory initially, Wepman had to determine something about the nature of the relationship between auditory discrimination and reading skills; Wepman (1960) employed his own test of phonemic auditory discrimination (Wepman, 1958) with first and second graders. The Wepman Auditory Discrimination Test consists of 40 pairs of words presented orally by the examiner; 10 pairs are identical and 30 pairs differ only in a single phoneme (e.g., pin/pen). The child's task is to say whether the words in each pair are the "same" or "different." The test is administered individually. Wepman found that those children who performed poorly were, in fact, poor readers, and those who performed well were good readers. Wepman repeated this study a year later with another sample of first and second graders. Again, he discovered that those who failed to determine if the words were identical or differed were poor readers (Wepman, 1961).

A number of results have been interpreted as further support for the relationship between phonemic auditory discrimination skills and reading ability (e.g., Deutsch, 1964; Katz & Deutsch, 1967; Oakland, 1969; Peck, 1977). They have all reported moderate to strong positive correlations (.6 to .8) between phonemic auditory discrimination and reading achievement in elementary school populations. For example, Katz & Deutsch (1967) and Deutsch (1964) used Wepman's assessment to determine the auditory discrimination ability of separate samples of first graders and discovered that this factor was useful as a predictor of word recognition ability in the 2nd grade. Like Wepman (1960, 1961), they could easily differentiate students into the categories of potentially good or potentially poor readers based upon the knowledge of their auditory discrimination scores. Oakland (1969) wanted to extend the score comparisons to include reading comprehension. Oakland assessed 60 first graders' auditory discrimination ability and examined the relationship between these scores and students' current scores on word recogniton and sentence comprehension tests. The correlations were strong (r =.7). Peck (1977) was interested in determining the nature of the relationships of several visual and auditory factors to reading achievement (both recognition and comprehension). All the measures were taken concurrently, with first graders as subjects. Along with a strong correlation between memory and reading achievement (composite score), Peck also determined a strong relationship between reading achievement and her measure of auditory discrimination. It must be noted that there are methodological problems with some of these studies. For example, Katz and Deutsch (1967) and Deutsch (1964) ran their studies on socioeconomically disadvantaged populations. Their results may not generalize to others. Further, Oakland (1969) did not control for intelligence differences. Because of such problems and because there are other studies which only report low correlations (on the order of .2 to .4), some authors do not believe that Wepman's ideas are, as yet, empirically subtantiated to any strong degree (e.g., Dykstra, 1966; Hammill & Larsen, 1974).

Perhaps the most opposing opinion to Wepman's is that offered by Dykstra (1966). Upon reviewing the literature, Dkystra discovered contradicting results. As he went from study to study, he found widely varying values in the degree of correlation between measures of reading achievement and auditory discrimination. As a result, he conducted his own study to determine the predictive efficacy of each of several tests gleaned from the literature which purportedly measure phonemic auditory discrimination skills (including Wepman's). Dykstra administered these measures at the beginning of the school year to a sample of over 600 first graders, and he assessed reading achievement (both word recognition and comprehension skills) at the end of the school year. He also administered a group test of intelligence. His results indicate that the best variable for predicting reading achievement was general level of intelligence. Yet, all of the auditory discrimination measures also correlated positively with both aspects of reading achievement, albeit to a lower degree. Five did, however, obtain coefficient levels as high as *r* =.4. These measures included: (1) discrimination between spoken words which do or do not begin with identical sounds (e.g., pan/ban), (2) detection of rhyming elements at the end of words (e.g., fair/bear) (3) identification of the correct pronounciation of words, (4) use of auditory clues with context clues to identify unfamiliar words (i.e., having the child identify a word [not in the subject's sight vocabulary] by listening to it spoken and by using the known words in the sentence frame), and (5) detection of similarities and differences in final consonant rhymes (brag/lag--same, thumb/strum--different).

Although a coefficient of .4 accounts for only 16% of the total variability and correlation does not imply causality, it may be sufficient to predict reading ability, especially given that phonemic discrimination skill is only considered a contributing factor to reading achievement. Guilford (1956) suggests that correlation coefficients with a range from .3 to .8 denote the "level of validity coefficients usually found for useful predictive instruments in psychology and educational practice" (p. 378), and those ranging between .2 and .3 indicate a "definite but small relationship" (p. 145). (see also Anastasi, 1982; Garrett, 1954). Then given that Dykstra obtained these coefficient values of +.4 and that the other auditory discrimination measures were all within the .2 to .3 range (including Wepman's), he may have overstated his conclusion. Dykstra strongly asserted that auditory discrimination, in itself, is probably not a significant factor in learning to read (see also Powers, 1971; Weiner, 1967). However, other reviewers have not been so quick to presume this.

In their comprehensive review of the auditory perception skills literature (dating back to the 1930's), Hammill & Larsen (1974) reported finding auditory discrimination and reading achievement correlation coefficients to be of widely varying value, also. Unlike Dykstra (1966), however, their reasoning takes note of the fact that the majority of these studies were not designed well. For example, as mentioned above about Oakland (1969), most studies did not report intelligence. And, as Dykstra pointed out above, general level of intelligence is probably a very important factor to consider when predicting reading achievement. Miller and McKenna (1981) have corroborated and have indicated that reported correlations between reading ability and intelligence, generally, have rangedfrom .4 to .9. They have, also, indicated that when subjects were of average or better intelligence, this relationship has tended to be stronger than when intelligence levels were low. Considering that RD students are of average or better intelligence, this factor must be considered in any work concerned with predicting reading ability in this group. Another design problem is that many of these studies did not control for socioeconomic status. I. Taylor et al. (1983) have pointed out that children from economically disadvantaged backgrounds have a greater tendency to have smaller vocabularies and to use non-standard English grammar than middle- and upper-class counterparts of comparable general intelligence. Presumably, this is due, primarily, to a poorer linguistic environment (or one not well-suited to academic situations). Finally, Hammill et al. have cautioned that most authors devised their own instruments to test phonemic discrimination, ad hoc, and the standardized reading achievement tests that they used were widely varying in type and scope across studies (i.e., some measured only word recognition, vocabulary, or sentence comprehension skills, others a combination of skills). Only a few researchers employed the same tests. Such disparity in methodology only hampers efforts at comparison of results, making fair evaluation of construct validty almost impossible (Aiken, 1979). Therefore, while Hammill et al. prudently advise educators not to depend solely on phonemic discrimination measures when making predictions about reading achievement or when developing plans for reading instruction, they do not discount the possible role of phonemic discrimination in reading. They simply caution that Wepman's claims have not been supported conslusively. Unfortunately, in her review of the literature subsequent to Hammill et al. (1974), Harber (1980) concluded that the literature was still fraught with the same methodological inconsistencies that Hammill et al. exposed.

At this point, it must, also, be noted that the focus of the literature has not been on testing the validity of Wepman's ideas. The research has been primarily involved with investigating the reliability of auditory discrimination as a predictor of reading ability. And, the studies have been of a correlational nature. Correlation does not imply causation. Until design considerations such as those discussed are met widely in the literature, clear evaluation of the validity of Wepman's contentions will only be impeded.

The lack of conclusive empirical support for Wepman's position has prompted other verbal processing deficit/inefficiency theorists to draw the focus away from perception, per se, and toward the students' "awareness" of the structure of language. Recent research has been interpreted to support this second line of phonetic research.

<u>Phonetic Metalinguistic Awareness</u>

Contemporary research into the linguistic development of children has become increasingly concerned with their ability to reflect upon the structure and function of language. With such ability, the child can treat language, itself, as an object of thought. This is opposed to its simply being used, implicitly, to comprehend and produce words and sentences. Metalinguistic ability emerges during early childhood and comes in many forms. Evidence of metalinguistic awareness includes: the appreciation of puns (Read, 1978), the ability to judge whether a sentence is grammatically correct (Carr, 1979), the ability to segment sentences into words (Tunmer & Herriman, 1983), and the ability to segment words into phonetic constituents (e.g.,I. Liberman, Shankweiler, Fischer, & B. Carter, 1974; I. Liberman, Shankweiler, A. Liberman, Fowler, & Fischer, 1977; Shankweiler, I. Liberman, Mark, Fowler & Fisher, 1979).

The present focus is on the phonetic level of language. Being able to segment words into their component sounds presupposes an awareness of the phonetic structure of words. As Shankweiler et al. (1979) explain, this is no mean task because such boundaries are not clearly marked acoustically in the speech signal. Phonetic segments are often coarticulated; many times a consonant will be merged with a vowel. For example the word <u>bag</u> has three phonetic segments but only one syllable. In order to be able to segment words into their phonetic constituents the person, first, must know that such things exist.

The English alphabet is not perfectly representative of all the speech sounds of English (there are roughly 44 phonemes and only 26 letters). And, there is evidence that alphabetically written words may be learned to be recognized by overall shape (as do learners of logographies, such as Japanese kanji or Chinese) (Guttentag, 1981; Tzeng & Hung, 1980). Such words may also be learned to be recognized by visual analogy to words with which the reader is already familiar (Massaro & G. Taylor, 1980; Treiman, 1984). However, as Mann and I. Liberman (1984) have pointed out such visual association strategies, alone, are relatively ineffective when the reader encounters a totally unfamiliar word.

Spelling-sound correspondence. Thus, taking into consideration that a completely visual reading system would be ineffective under such circumstances, interest in phonetic-level metalinguistic abilities, such as phonemic segmentation, has grown. In conjunction with this, theorists have invoked the idea that acquisition of spelling-sound correspondence (SSC) rules provides an important key for reading in decoding (i.e., identifying or recognizing) written words in an alphabetic writing system.

Several researchers have reasoned that if the reader can employ both aural and visual coding strategies, he or she has a real chance of correctly identifying any word, even a totally unfamiliar one. For example, I. Liberman and Shankweiler (1979) have proposed that, in order to learn SSC rules, the student must realize that words are composed of syllables and, more importantly, that syllables are composed of letters. Further, they have contended that the student's knowledge of speech sounds must become explicit if he or she is to develop ease in relating varying combinations of written letters to their sound counterparts. With such knowledge, the reader is able to acquire SSC rules and apply them in the strategy of "sounding-out" (either aloud or silently) each letter (or group of letters). When confronted with an unfamiliar word, the reader equipped with SSC rule knowledge can decipher it by combining the sounds (phonemic representations) of the letters to form the target word (or some phonemically similar identification). By extension, readers, who for whatever reason, cannot access or who fail to employ phonemic strategies effectively, are believed to be relatively insensitive to the phonemic structure of spoken language and, thus, inefficient in word decoding (Ehri & Wilce, 1983; Manis & Morrison, 1985; I. Taylor et al., 1983; Treiman & Baron 1981; Vellutino, 1978).

Several studies serve to document that many disabled readers experience greater difficulty than do non-disabled readers in learning phonics--learning to map the phonemic structure of spoken language onto graphemic counterparts (Calfee, 1982; Gleitman & Rozin, 1977; Jorm, 1981; Kochnower, Richardson, & Di Benedetto, 1983; Rozin & Gleitman, 1977; Shankweiler & I. Liberman, 1976; Snowling, 1980; Stanovich, 1982). And, Baron and Strawson (1976) report that this is the case even when an artificial alphabet is used as visual stimuli.

Further, support for the idea that disabled readers have difficulty in using (SSC) rules has come from studies which employed nonword letter strings (e.g., lux, shum, cral, briw) rather than real words, as visual stimuli. Nonwords were used with the general reasoning being that, because such stimulus items could not have been taught to be recognized visually prior to the study, the subjects would have to rely on "sounding-out." This, in turn, relies on the ability to use spelling-sound correspondence rules. The studies have indicated that whether the subjects were asked to read, pronounce, or spell nonwords, the responses of RD students were comprised of significantly more errors than were the responses of NRD counterparts (Calfee, Venezky, & Chapman, 1969; Ehri et al., 1983; Firth, 1972; Hogaboam & Perfetti, 1978; Perfetti & Hogaboam, 1975; Siegel, 1985).

Also, because the contention is that attempting to decode unfamiliar words may involve the reader joining together component phonemic representations, a number of reserchers have required subjects to try to identify, as real words, strings of individual phonemes, presented aurally (e.g., Calfee, 1982; Fox & Routh, 1975; Hardy, Stennett, & Smythe, 1973). For example, the subject may be presented with the string /p, e, n, t/, with each phoneme distinct; then he or she is expected to identify the string as the word paint (or e.g., /b, ə, t, n/ as button, etc.). With this method, disabled readers, again, performed significantly worse than non-disabled readers. And, Calfee (1982) reports that his sample of disabled readers remained inferior on such tasks even through the sixth grade (the highest grade studied).

Thus, collectively, there is a body of evidence which points to disabled readers having difficulty in learning SSC rules. Unfortunately, despite several years of investigations (as with reading disabilities, in general), there is not, as yet, a definitive answer as to the possible cause(s) of such deficiencies. However, in concert with the spelling studies addressing reading group differences in SSC performance, there are several investigations which examine the supposedly more fundamental problem: groups differences in phonemic sensitivity (Manis et al., 1985).

Phonemic sensitivity. As discussed earlier, to acquire SSC rules one factor that has appeared to be important is that the student must be aware of the phonemes which compose words. Students who are relatively insensitive to the structure of spoken language are believed to be at a disadvantage when they must attempt to relate sound to letter or letter combinations (e.g., I. Liberman et al., 1977; Shanweiler et al., 1979; Treiman et al., 1981). A number of authors have argued that in order to learn such correspondences, children must acquire the ability to analyze spoken words into phonemes. In an early study, I. Liberman et al. (1974) compared nursery school, kindergarten, and first grade students on their ability to tap out the number of syllables and of phonemes within words. Their results indicated that the detection of the number of syllables was an easier task than detection of the number of phonemes and that skill for the latter increased with age. Further, cross-sectional and longitudinal studies have revealed that phonemic segmentation skill is highly associated with achievement on standardized reading tests, especially during the early school years (Calfee, P. Lindamood, & C. Lindamood, 1973; Fox et al., 1975; Helfgott, 1976; I. Liberman et al., 1974; Treiman et al., 1981; Zifcak, 1976).

The general hypothesis that has been put forward to explain disabled readers' apparent relative insensitivity is that RD students are, somehow, less efficient than NRD students in the phonetic-coding of information into short-term (or working) memory (Vellutino, 1979; I. Taylor et al., 1983).

Several authors have suggested that many RD students who are defined as disabled because of poor word decoding skills are somehow impaired in their ability to retain full phonetic representation of the sounds of speech (e.g., Brady et al., 1983; Mann, Shankweiler, & S. Smith, 1984; Olson, Kliegl, Davidson, & Foltz, 1985; Shankweiler et al., 1976).

Generally, such investigators have speculated that the NRD student initially learns SSCs for letters and builds on this information by learning how the sounds of letters change according to word context. They have reasoned that the reader may, then, use this knowledge to help decipher unfamiliar words.

Thus, they have characterized the NRD student as taking the phonetic representation that he or she has gleaned from listening to a spoken letter, as referring to the information that is stored in long-term memory (LTM) concerning whether the sound that is heard is an acceptable language sound, and as, thereby, translating the phonetic representation into a phoneme. Then, the student stores the phoneme in short-term memory (STM), where it can be associated with its visual counterpart--the grapheme. The phoneme-grapheme association, then, becomes stored in LTM for future reference. As the student learns more about how the sounds of letters can vary given changes in context (e.g., how the letter c sounds differently within the words celery, calorie, and church), this information is also stored in association with the letters. Thus, these authors have contended that in the NRD reader who has learned the grapheme-phoneme correspondences fully, decoding by letter-sound ("sounding-out") analysis becomes a viable strategy.

However, if for some reason the student's phonetic codes are of a weak or degraded nature, efforts at translating them into phonemes would be hampered. And, the authors have posited that it is this difficulty in constructing phonemes for association with graphemes which serves to retard the learning of SSCs.

Phonetic Coding and Reading Comprehension

Although they have not discounted the importance of such factors as level of attention and prior knowledge of subject matter, several reading comprehension authors have also looked to possible problems with phonetic coding to help explain reading group differences in the comprehension of connected prose. Specifically, in tandem with the SSC authors, previously noted, they, too, have reasoned that if the reader is a poor word decoder by reason of weak phonetic coding and, thus, posessing little spelling-sound knowledge, he or she may have difficulty in deciphering unfamiliar words. To the extent that these are key words to the meaning of the passage, comprehension falters. A separate branch of comprehension theorists also have looked to a possible role of phonetic coding in retaining words in STM so that specifics of the passage are available to the reader.

Several reading theorists have noted that the reader may attempt to use contextual cue strategies--not just spelling-sound knowledge (Goodman, 1968). For example, if an article precedes a word, the reader can, at least, presume that it is a noun, and if he or she knows the general gist of the passage (or paragraph, etc.), this may narrow down the choice of possible candidates. But, as Ellis (1984) and Vellutino (1978, 1979) have explained, such strategies are inefficient when compared to the use of SSCs. Thus, even though the reader may know, for example, that the word is a noun and that the general gist concerns a car accident, the list of possible candidates for the unknown word is still quite large. However, if the reader "sounds-out" the word, that list of possibilities becomes narrowed down to the correct word or one closely approximating it phonetically. Then, the reader can use contextual cues to decide among the candidates. Thus, use of SSCs in conjunction with contextual cues can provide the reader with an efficient strategy system for decoding unfamiliar words in text. Because the use of spelling-sound knowledge within this system may narrow down the choices so efficiently, these authors have speculated that the student who does not have this knowledge is at a distinct disadvantage when trying to read texts containing words which are unfamiliar by sight.

Other authors, also, have focused on the role of phonetic coding in reading comprehension. But, unlike the above authors, they have looked to its use to store linguistic stimuli in STM. Focus on this has come about, primarily, because of a consistent finding that has been reported in the literature. As has been found with NRD students (Mitchell, 1982), several studies have revealed that many disabled readers show no impairment in retaining the global meaning (i.e., general gist) of a passage (Benger, 1975; Straub, 1976), but unlike non-disabled readers, they tend not to retain specific details of the text, such as grammatical markers of tense and number, nor to recall word strings verbatim, when required to do so (Byrne, 1981; Golinkoff & Rosinski, 1976; Perfetti, Finger, & Hogaboam, 1977; Perfetti et al., 1978; Satz, et al., 1978; F. Smith, 1967; Waller, 1976). Also, this pattern of results has been reported for students in kindergarten and the early as well as later elementary grades (Lovett, 1979).

Although the reader (unlike the listener) may glance back over a passage in order to refresh the memory, several theorists have pointed out that in order to read with any real effectiveness, the reader cannot be continually retracking the text. (For a review of the issues involved in defining reading efficiency, see Ellis, 1984, I. Taylor et al., 1983, and Underwood, 1985). They have postulated that the comprehension of connected prose (whether written or spoken) requires that the reader (or listener) keep track of incoming propositions in such a manner that the exact wording can be maintained until it can be assimilated into higher-order units of meaning. And, for that purpose, they have speculated that phonetic coding may provide the reader with a useful strategy for retaining linguistic information in STM (Baron, 1977; Barron 1978, 1981; Kintsch & van Dijk, 1978; Kleiman, 1975; Levy, 1975; P. Smith & Baker, 1976). Further, they have likened the reader's phonetic coding of the visual representation of language to both reading and listening to the text; they have posited that by employing both visual and speech codes, the reader can obtain two chances to decipher and retain the material (Slowiacek & Clifton 1980).

Therefore, given that both reading comprehension and word decoding theorists have hypothesized that phonetic coding may provide a valuable aid to readers, one might expect to find evidence of its greater use by NRD than RD students. What empirical support is there for the presence of phonetic coding in normal readers and for reading group differences in its use?

Phonetic Coding: Empirical Evidence

Research from several types of studies has provided evidence of normal, adult readers employing phonetic coding with visually and aurally presented linguistic stimuli (e.g., letters, words, sentences). The results of several early memory experiments are what have provided the primary rationale for a widely used means of empirically examining coding differences between RD and NRD students. Studies which have used a methodology that relied upon the phenomenon of phonemic confusabilty when they explored children's coding of linguistic material have shown that disabled readers tend not to rely on phonetic coding as much as do non-disabled readers. Yet, it must be noted that in some studies which have compared reading groups composed of older subjects (i.e., 9 years and older), the pattern of results has differed from that when younger students have served as subjects. Recent researchers have offered two possible explanations for this.

Evidence of adults' sensitivity to phonetic form. As alluded to, the results of several studies have evidenced the influence of phonetic coding in normal, adult, readers. What follows is a sampling from dozens of investigations in the literature.

For example, Spoehr (1974) found that when subjects were required to immediately recognize tachistoscopically presented words their accuracy decreased signficantly as the phoneme and syllable length increased, holding word length constant. Such a result was unexpected because in words with more syllables there is usually more vowel-consonant alternation, and this was expected to make the words more recognizable, not less. In a similar vein, Erickson, Pollack, and Montague (1970) discovered that their readers took longer to recognize printed words whose sounds contained more syllables than words of identical grapheme length but fewer syllables (see also Klapp, 1974; Pynte, 1978).

Also, in studies which employed letter cancellation tasks, if the target occurred in an accented syllable, it was more likely to be detected than if it occurred in an unaccented one, no matter what its location in the word (Drenowski & Healy, 1982; Hatch, Polin, & Part, 1974; P. Smith & Groat, 1979). This implied that the subjects were attending to the sounds of the targets, not just their visual features. Further, in such studies, profoundly deaf groups have tended not to miss silent e (e.g., in words such as fine, stove, name) as much as did hearing and hearing impaired groups (Chen, 1976). And, Locke (1978) reported the same results using other silent letters.

Jac obson (1976) required subjects to try to name words presented tachistoscopically when the words were masked by other words presented immediately afterward. The target words were strongly masked by homophonic distractors (i.e., words which sounded similar to the targets--e.g., sew with so and too with threw) but not by semantically related words (e.g., play, pitched). And, in a recent study, Salame and Baddeley (1982) required their subjects to recall a string of 9 digits presented visually in sequence on computer display while hearing but not attending to spoken words. The words interfered with the recall of the digit sequence and more strongly so if they were phonemically related to the digits (e.g., ton for one, new for two, tee for three) than if they were not (e.g., jelly, tennis, ball). This sequence recall performance difference lends support to the idea that the subjects may be using phonetic coding to hold the visual input verbatim. When the phonetic coding is disrupted (presumably because of the phonemically similar input), the exact ordering of the digits is lost, even though both groups retained the individual items equally.

To try to tap into sentence processing, P. Cunningham and J. Cunningham (1978) used a passage about six fish. In one condition the names within the passage were pronounceable (e.g., doffit, mintex) and in the second condition their names were unpronounceable (e.g., dfofti, mnitxe). The subjects who had the pronounceable names silently read the passage signficantly faster than did the subjects in the other group. After reading, the subjects had to indicate the particular fish who had certain traits described in the passage. The former group performed better on this comprehension-recall test, also.

Further, other researchers examining sentence processsing have employed a technique known as concurrent articulation in order to disrupt phonetic coding and to observe the resulting effect on comprehension. The effects of concurrent articulation were first reported in Pintner (1913). Pintner required subjects to continually repeat irrelevant words while reading. He discovered that reading was impaired at first. But, after practice, the effect diminished. Bearing in mind the practice effect noted in Pintner's study, several recent authors have employed concurrent articulation methods and found support for the idea that phonetic coding aids comprehension by retaining the specific linguistic elements of a passage.

For example, Levy (1978) discovered that concurrent articulation adversely affected his subjects' detection of specific word changes in sentences. In a related study, Baddeley, Eldridge, and Lewis (1981) found that overt counting increased the chances that subjects would miss the anomalous word in the following complex sentence: "She doesn't mind going to the dentist to have fillings, but doesn't like the rent when he gives her the injection at the beginning" (p. 445). However, such counting did not interfere with the overall comprehension of the gist of normal sentences. Baddeley et al. (1981) also required a group of subjects to tap on a table while they were reading. The concurrent tapping had no ill effect. This finding lead these authors to conclude that concurrent articulation is detrimental because it involves speech coding rather than simply because it is a concurrent task (see also Slowiacek et al., 1980; Levy, 1975).

Finally, although spelling and reading are believed to be different tasks, several authors have thought of them as requiring many of the same processing resources (Ellis, 1984; Frith, 1980; I. Taylor et al., 1983; Vellutino, 1979). And, several researchers have used misspellings as a means of tapping phonetic processing in readers. For example, MacKay (1968) required subjects to search through a prose passage for words spelled incorrectly. Some were misspelled in a phonemically compatible way (e.g., "hurd for heard) and others were phonemically incompatible (e.g., "borst" for burst); the subjects were more likely to detect the phonemically incompatible errors. Further, researchers have reported evidence of readers' written misspellings being phonemically constrained. Sears (1969) examined the spelling errors identified by the publications department of an aerospace company. Of more than 100 errors, over 92% were phonemic (e.g., "priar" for prior and "murge" for merge). The author concluded from this that engineers spell "acoustically." But, non-engineers also tend to make such phonemically similar errors, as well (Alper, 1942; Barron, 1980; Bryant & Bradley, 1980; Doctor, 1973; Frith, 1979; Plessas, 1963). Also, I. Taylor et al. (1983) have reported that Japanese publications in English sometimes have misspellings in which there are l-to-r substitutions (e.g., "crub" for club), reflecting Japanese speech in which these English phonemes are not distinguished.

Although, collectively, the above studies strongly indicate that normal, adult readers are influenced by the sounds (or phonemic representations) of written words, thus far, investigations of the following type have been the most influential to the study of phonetic coding in disabled readers.

Phonemic confusability: Adult results. Based upon examination of the errors of normal, adult subjects in immediate recall tasks, a number of researchers have inferred that phonetic representation serves memorial processing (Baddeley, 1966, 1968, 1970; Conrad, 1963, 1964, 1971, 1972; Conrad, Freeman, & Hull, 1965; Conrad & Hull, 1964; Dornic, 1947; Estes, 1973; Hintzman, 1967, 1969; Sperling, 1963; Wickelgren, 1965). Within this series of investigations, the subjects had to recall briefly presented lists of linguistic stimuli. When they made errors, their confusions tended to be phonemically, not visually, related to the target item. For example, Conrad (1964) visually presented to college students lists of six letters from a vocabulary of the following: _B_, _C_, _P_, _T_, _V_, _F_, _M_, _N_, _S_, and _X_. And, as have such normal, adult readers in later studies, Conrad's subjects made errors which tended to rhyme with, rather than visually resemble, the missed target items (e.g., _T_ or _B_ would be recalled for _C_ but tend not to be recalled for _F_). Conrad termed this type of error one of _phonemic confusability_.

In studies subsequent to Conrad (1964), it did not matter whether the information was in the form of letters, syllable, words, logographs, or readily labelable pictues (of concrete objects, animals, or people), or whether the stimuli were presented visually or aurally. Consistently, researchers have reported that confusions in recall were greater when the items were phonemically similar (i.e., rhyme) than when the similarity was visual or semantic (Baddeley, 1966, 1979; Conrad, 1972; Conrad et al., 1964; Erickson et al., 1977; Tzeng, Hung, & Wang, 1977). Consequently, such findings suggest that adult perceivers have so strong a tendency to code linguistic information in a phonetic form that they continue to do so even when it penalizes their recall, and, further, that phonetic coding is a widely applicable strategy for storing any information that can be linguistically processed. Thus, the phenomenon of phonemic confusability has been considered by many researchers to be a reliable means of indicating the presence of phonetic coding and, therefore, to be a possible key to examining reading group differences.

Phonemic confusability: Results with young students. In an initial attempt to determine if coding differences exist between disabled ("poor") and non-disabled ("superior") readers, I. Liberman et al. (1977) employed a procedure with 2nd-grade students based upon the findings reported in Conrad (1964). The children's reading groups were compared on their immediate recall of lists of letters which either rhymed or did not. The results of the study indicated that their young NRD students resembled adults in that their recall was strongly affected by rhyme (i.e., phonemic confusability), while the RD students experienced no difference in recall between the rhyming and non-rhyming conditions. Also, even though the non-disabled readers recalled fewer letters correctly under the rhyming condition than they did under the non-rhyming condition, their performance was better, even in the rhyming condition, than was that of disabled readers in either condition.

The results of this investigation have provided impetus for a series of experiments with primary school students comparing RD and NRD subjects' phonetic coding using the phonemic confusability effect. These experiments have replicated and extended the I. Liberman et al. (1977) findings under a variety of conditions: when memory was tested by recognition as well as recall (e.g., Byrne et al., 1979; Mark et al., 1977), when the items were presented visually or aurally (e.g., Brady et al., 1983; Shankweiler et al., 1979), and when the items were nonsense syllables (e.g., I. Liberman et al., 1982; Perfetti et al., 1976), words (e.g., Mark, Shankweiler, I. Liberman, & Fowler, 1977), word strings or sentences (e.g., Barron, 1977; Mann, I. Liberman, & Shankweiler, 1980; Wiig et al., 1980). Such consistent findings provide considerable support for the idea of reading group differences in phonemic confusability and, to the extend that phonemic confusability is related to phonetic coding, to group differences in the use of phonetic coding. Of important note here, however, is that a few phonemic confusability studies using older students as subjects have revealed a different pattern of results.

Phonemic confusability: Results with older students. In contrast with the results of the above studies dealing with phonemic confusability and young readers, several, recent studies have revealed that rhyming may differentially impair the retention of linguistic stimuli by older students. For example, Siegel and Linder (1984) found that their older disabled readers (ages 9 to 14 years) showed sensitivity to phonemic confusability in their recall of auditorially and visually presented letters. Their confusions were on par with NRD age-mates. Bisanz, Das, and Mancini (1984) have also reported the effect in 6th-grade students under conditions of delayed recall. And, Olson, Davidson, Kliegl, & Davies (1984) have employed a recognition task with their subjects (mean age 15.4 years) and achieved similar results.

Such findings have called into question whether phonemic confusabilty reading group differences and, perhaps, phonetic coding differences continue into adolescence. Even though this is a question which is still open to much speculation (and with little data) (Bisanz et al., 1984; Manis et al., 1985; Siegel, 1985; Wolford, 1985), two general positions have been offered to account for the present results.

The more parsimonious explanation is that older reading groups really do not differ in phonetic coding ability (as assessed by phonemic confusability measures) (Johnston, 1982; Siegel, 1985). These authors have discussed this position in terms of the developmental delay (lag) hypothesis. Here the RD student is seen as being on a normal, albeit slower, course of cognitive development. Thus, whatever the underlying cause of the delay, these theorists do not believe that it is a permanently disabling abnormality (e.g., Benger, 1968; Lerner, 1981). Johnston and Siegel have posited that by the time RD students reach adolescence, many of them may have "caught up" with age-mates.

Olson et al. (1985) have advanced the second explanation. They have proposed that one does not have to conclude from the above null results that there is no difference between the phonetic coding of these older groups of readers. Such a position is in agreement with the general, phonetic coding inefficiency hypothesis discussed earlier. Olson et al. have made this assumption based upon close examination of the results of their own study with older students. They discovered that their disabled readers were affected by rhyme even more than the non-disabled readers were. These authors have reasoned that such results imply that the phonetic coding ability of the older readers may be better than that of younger RD pupils but still not quite as efficient as that of NRD age-mates.

It should be noted that, despite their differences, both positions point to improvement in the older RD students' phonetic coding. Cross-sectionally sampling NRD students ranging in age from 5- to 11-years, Conrad (1971) has indicated that there may be a tendency toward greater use of phonetic coding with age. In Conrad's sample at age 11, it became the primary form of coding linguistic material. This information combined with the phonetic coding data on NRD adults, discussed earlier, indicates that the the more mature coding form may be phonetic. Thus, the evidence of use of phonetic coding in older RD students may not simply signal a change in type of coding strategy, but a compensatory change. Given this, both of the above explanations allow for the role of compensation with age. At this point, neither the position of Olson et al. or Johnston and Siegel has been sufficiently researched to warrant pursuing one to the exclusion of the other. And, the nature of the development of the compensation is unknown.

The majority of all studies concerned with reading disabilities have been done with the "traditional" design. This design only compares RD versus NRD age-mates (Backman, Mamen, Ferguson, 1984). However, it must be noted that such a design would not be appropriate to test the developmental lag hypothesis. If RD students are on a normal course of development, just slower than normal, then they should show some similarities to younger students in those cognitive skills involved in reading. Most of the available studies examining RD versus NRD students have defined their RD population as being at least two years behind age-mates. Thus, a starting point in empirically examining both positions would involve researchers incorporating in their studies reading level controls who are at least two years younger than the RD subjects. Also, in order to explore the idea of Olson et al. (1985) that RD and NRD students remain qualitatively different in performance, age-mates must also be included. This would allow for analysis of the types of responses made by age-mates. Including age-mates also allows for comparison of the tested ability (i.e., phonemic confusability) across two reading levels of NRD students. Although this is a cross-sectional sampling, just as Conrad (1971), it may give some insight into what constitutes "normal" development of this and other reading-related skills in the school years.

Speculated Underlying Causes

As indicated earlier, the spelling-sound and reading comprehension theorists have pointed to weak phonetic coding in RD students or their failure to use it, but they have not focused on what may cause the "weakness." What may limit the RD student's performance on tasks requiring phonetic processing? Recently, three ideas have been offered in the literature as possible sources of the problem.

Several investigators, interested in describing problems of learning disabled children, have come to focus on memory skills as an area of potential deficit (e.g., Baddeley & Hitch, 1974; Bauer, 1977; Torgesen & Goldman, 1977; Torgesen & Houck, 1980).

STM capacity. In keeping with this, the first position offered to account for phonetic coding differences postulates differences in STM capacity between reading groups. Naidoo (1970) and Miles and Miles (1977) have reported that reading ability is related to memory span in ordered recall tasks. Accordingly, Baddeley and associates have proposed that RD students may have a smaller STM capacity than NRD age-mates (Baddeley et al., 1974; Baddeley & Lewis, 1981). They, along with others (Case, 1978; Daneman & Carpenter, 1980; Daneman, Carpenter, & Just, 1982), conceive of STM as "working memory" and consider it to be a site for executing processes as well as for storing the products of these processes. These functions compete for shared limited capacity. Given such a system, less efficient processes must decrease the amount of additional information that can be mantained in working memory. It is along these lines that Baddeley et al. (1974) and Baddeley et al. (1981) have formulated a model of verbal processing.

They have proposed the existence of a storing mechanism, termed the articulatory loop. It serves to maintain phonemically encodable material through subvocal rehearsal until the sounds can be blended by the second proposed component of working memory, the executive system. The executive system also serves to retrieve the item's meaning from long-term storage and to integrate items into higher-order units such as words, phrases, and sentences.

As empirical support for their articulatory loop storage system, Baddeley and associates have cited the previously noted effects of concurrent articulation. They have also pointed to a discovered tendency for the memory span of adult, normal readers to decrease as the length of words to be recalled increases (Baddeley, Thompson & Buchanan, 1975). Baddeley et al. (1975) found that this word length effect strongly related to the physical spoken duration of the items. In this study, words which can be articulated quickly (e.g., cricket, bishop) had a greater chance of being recalled than did words which take longer to speak (e.g., Friday, cyclone). This suggested to Baddeley et al. (1981) that the articulatory loop is time-based. From work with adult, normal readers, Baddeley et al. (1981) estimated it to be capable of holding the amount of information which can be articulated in 2 seconds.

Information can be lost from working memory through decay or displacement. Decay occurs over time if the information is not actively maintained (e.g., through rehearsal) (Collins & Loftus, 1975; Reitsma, 1974). Displacement occurs if additional items are subsequently encoded, activated, or constructed until the memory capacity is exceeded (Daneman & Just, 1980). One way to account for this is to view storage as also requiring some processing. If aperson is too involved in other processes (e.g., encoding) to do adequate maintenance processing, he or she may lose the stored information. Also, the processes in a demanding operation may generate intermediate products that displace the stored information. This is detrimental to the reading process. If working memory contains insufficient information, then subsequent processing will not be optimal. For example, if the reader encounters a pronoun, but the antecedent is no longer available in working memory, he or she will have to search LTM, make an inference, or fail to link the pronoun at that point in the text (Daneman et al., 1982).

With these limitations to working memory in mind, Baddeley and associates have characterized RD students as being slower than NRD students in encoding verbal information in memory. Because the articulatory loop can only maintain items for a limited amount of time, new items may displace the old or the old may decay before they are fully integrated and comprehended. As yet, they have not directly tested this position, but they have made reference to many of the studies of phonemic confusability comparing young RD and NRD students. They also have noted findings that RD students score poorer than same-age controls on the Digit Span subtest of the Wechsler Intelligence Scale for Children and on lists longer than normally encountered on this test (Senf & Freundl, 1972). However, it must be noted that these results are not conclusive. For example, Guyer and Friedman (1975) and Hunt, Frost,and Lunneborg (1973) have failed to find reading group differences on such digit span tasks.

Thus, current empirical support for this position is insufficient to draw any firm conclusions. Given no direct test of the hypothesis, simply making reference to phonemic confusability differences does not establish that reading group differences are due to differences in speed of encoding.

Memory strategies. The second available explanation serves to call the first into question, as well. Torgesen and colleagues have focused not on capacity differences between reading groups but on strategies for maintaining information in working memory (Torgesen et al., 1977; Torgesen et al., 1980). As the limited capacity hypothesis would predict, the Torgesen et al. (1977) RD subjects scored worse than age-mates in a delayed serial recall task. And, the RD students rehearsed less than did the controls during the delay interval. Yet, in stark contrast with Baddeley's ideas, both rehearsal and recall differences disappeared when the groups were trained in the use of verbal rehearsal.

Torgesen (1977) has characterized the learning disabled student as experiencing difficulties in the "management" of working memory, not as having a STM with smaller capacity. In Torgesen's conceptualizations, the RD student lacks a general awareness of his or her own cognitive processes (Torgesen, 1980). He has proposed that they are "inactive" learners; they have an inability or a lack of inclination to adopt task-appropriate mnemonic verbal strategies (e.g., rehearsal, labeling, and sentence elaboration) (Wong, 1980).

The effect of training in this study is striking. It may preclude the idea of RD students having a smaller working memory capacity, at least in as much as it can be remedied by appropriate mnemonic strategies. Subsequent, related research has supported the position that reading group differences are of performance and not ability. They, too, have shown that strategy training can eliminate group recall differences. When RD students have been made aware of strategies their age-mates already know how to use to help organize items in working memory, reading group differences in recall have disappeared. For example, Dallago and Moely (1980) successfully trained their 9 to 11 year old male subjects to semantically relate items. And, Miller (1982) discovered that categorization training on cued recall tasks eliminated reading group differences in her 12 to 18 year olds. As well as lending support to the strategy position, such results also point to strategy training's remediational value

Speech perception. The third explanation offered does not address the above arguments concerned with memory capacity or strategy differences, per se. Its focus, instead, is on possible reading group differences in speech perception. The general reasoning is that if the child has a deficit in perceiving the sounds of speech, he or she will not have accurate phonetic representations of those sounds to facilitate reading (Brady et al., 1983; Godfrey, Syrdal-Lasky, Millay, & Knox, 1981). As support, these authors have pointed to the available empirical evidence which has strongly indicated a RD versus NRD phonetic (speech sound) coding difference. Particularly, they have focused on the fact that the reading group difference remained no matter whether the items were presented visually or aurally (e.g., Fox et al., 1975; Hardy et al., 1973; Shankweiler, et al., 1979). This work has provided support for the idea that RD subjects have difficulty with phonetic coding apart from its conversion or recoding from print. This finding combined with the earlier clinical data hinting of a link between difficulties with spoken and written language, has provided sufficient cause for researchers to begin to investigate speech perception abilities in RD students (Brady et al., 1983; Godfrey et al., 1981).

Godfrey et al. and Brady et al. employed different methods, yet both discovered reading group differences. Godfrey and associates employed synthetic speech signals in a categorical perception task. To do this, they varied a single acoustic cue at a time to determine the discriminability of the change and its effect on the perceived identity of the stimulus as one phoneme or the other (ba vs. da; da vs. ga). Unlike Wepman's (1958) test this method of presentation allowed for precise computer control of the stimulus properties without the variability introduced with natural human speech. With this method, Godfrey and associates discovered that RD students differed from NRD age-mates (10 year olds) in both identification of phonemes and in detection of acoustic changes. The RD students were less consistent in their identification of stimuli and changed more gradually from one phonetic category to another than NRD counterparts.

In their speech perception test, Brady et al. (1983) required 8-year-olds to repeat each of 48 words presented via recorded human voice. Rather than the precise control of a speech synthesizer, the recording, here, allowed for the elimination of variability in production over presentations. Using an actual human voice also made for more ecologically valid listening conditions than using a synthesizer. Also, the selection of item type also provided some control. For example, words were grouped according to phonetic composition (words beginning with stop consonants, fricatives, or affricates). And, the words were divided into high and low frequency words (based upon occurrence in children's literature). Subjects listened to the words under masked and unmasked conditions. Also, the subjects listened to a tape of environmental sounds again with white noise and without to determine if there were perceptual differences specific to speech or to some more general auditory processing deficit. This condition further served to determine effects of reading group differences in attention.

Although both reading groups suffered a detrimental effect of white noise on perception, the effect of degraded signal was significantly worse for the RD students. There was no group difference without masking. The high and low frequency words were employed as a means of determining whether differences between groups in perception of the items were attributable to differences in vocabulary skill. There was no group interaction, so the poorer performance of RD students could not be attributed to differences in word knowledge. Also, there was equality of performance for NRD and RD students on the nonspeech auditory task. Thus, they could rule our inattention as an explanation for the poor performance on the noise-masked speech perception task. This also suggests that the problems RD students have with degraded speech is not a consequence of some general auditory deficit in perceptual ability, but rather is related specifically to the processing requirements for speech.

Investigation of speech perception abilities may prove to be a fruitful avenue of research into the cognitive processsing of RD students. The results of these studies are in line with those of the phonemic confusability work. Both Godfrey et al. (1981) and Brady et al. (1983) have provided semincal empirical evidence of speech perception differences between reading groups composed of age-mates, particularly when the acoustic signal is degraded.

As pointed out earlier the speech signal, alone, cannot convey the speaker's intended meaning, the listener must, somehow, contribute relevant information in the process of decoding speech. Because disabled readers were shown in Brady et al. to have greater difficulty than non-disabled readers with a degraded speech signal, it is reasonable to conclude that there may be reading group differences with regard to what is involved in the decoding process. The present research investigates the role of two factors: priming and word form on the speech perception of RD and NRD age-mates, younger NRD students, who served as reading level controls, and young RD students.

Speech Perception and Phonetic Ambiguities

Theoretical background. Although many theories have been devised in attempts to explain how humans extract meaning from speech sounds, it is a question left largely unanswered. This is the case even with the non-disabled listener. The complexity of speech perception is realized only when one considers the intricacies 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 oral production of these is almost as variable in nature as the the speakers, themselves.

Most speech perception theorists assume that the information processing system does not process information instantaneously.

Rather, they believe that the transition from the detection of speech's acoustic signal to its identification occurs in stages (Cooper, 1979). One model dealing with the perception of isolated speech sounds maintains that comprehension is brought about in three stages. 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 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. Lastly, during the phonological stage, the listener adjusts the memory to be in accordance with the constraints of his or her language. The final information is then passed on to STM where it becomes conscious (Pisoni & Sawusch, 1975; Studdert-Kennedy, 1976). This model may sound familiar. Its general form was adopted by the SSC theorists discussed earlier.

Although this model or some general form of it has been popular in the reading literature, it has a major drawback. It cannot accommodate the variability inherent in normal, conversational speech. 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. Further, acoustic cues are not he same under all conditions of speakers, intonation, or stress. Even within the same speaker there is variability in production. Thus, this model is far too simplistic to account for how the listener handles normal, continuous speech.

In an effort to rectify this shortcoming, some theorists have assumed that humans have an internal speech synthesizer which operates on a weak version of the motor theory of speech perception. They have postulated that listeners abstractly model the speaker's articulatory gestures and, relying on acoustic cues which would result from that model, generate phonetic representations of the sounds which they match with incoming acoustic cues (e.g., Halle & Stevens, 1962). This idea shares some similiarity to Dodd et al.'s (1983) account of how the lip-reading CPD student may generate pseudo-phonetic mental representations. However, the analysis-by-synthesis position also has its limitations.

The above explanation would be adequate if the acoustic properties of speech were unambiguous. However, in normal speech, this is rarely the case. There is usually some background noise. Speakers tend to 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). In order for speech to be accurately decoded given such poor acoustic support, the listener must compensate somehow. The most likely explanation is that listeners are continuously employing hypotheses about what the speaker has said (H. Clark & E. Clark, 1977). Further, these listener hypotheses cannot be mere random guesses, because reported casual speech misperceptions are not random. For example, Garnes and Bond (1975, 1977) have demonstrated that such errors made by adult listeners show semantic and syntactic similarity with the speaker's actual expression. But, top-down processes, alone, cannot provide the total answer. A system that is completely top-down driven would entail that we could <u>only</u>

perceive what our past experience dictates, for example. Such a system is not very efficient and not likely to be what actually goes on during perception (Fodor, 1983). Thus, the listener must take into account the constraints provided by the incoming acoustic information, also (Marslen-Wilson & Welsh, 1978).

As in the case of the present investigation, one method of examining factors which humans may use to decode speech has been to present them with stretches of speech known to be ambiguous. Ambiguity refers to any case in which a single stimulus is perceivable in more than one way. Several types of ambiguities arise in speech. For example syntactic ambiguities occur when the same words are perceived to be in different structural relations. A sentence such as "Visiting relatives can be boring" can be interpreted two ways: the relatives who visit you can be boring, or the act of visiting relatives is what is boring. Lexical ambiguities involve words, themselves. Words such as park, clown, and fall, are ambiguous because they, each may be perceived as nouns or as verbs. Of most relevance to the present study are phonetic ambiguities. This form of ambiguity is the result of a given phonetic sequence being interpreted in more than one way (e.g.,cracker/quacker; eight tea cups/eighty cups) (Hirsh-Pasek, L. Gleitman, & H. Gleitman, 1978).

Research efforts. Investigation into the perception of phonetic ambiguities by adults have focused on several factors. For example, Lindsay and Norman (1977) used phonetic ambiguity to show that the listener must make reference to semantic and syntactic information in order to choose appropriate word organization within phonetically ambiguous sentences. Derwing (1973) and Bolinger (1975) also took the position that such upper-level processing is the more critical factor in the ability to disambiguate at the phonetic level.

The opposite position was expressed by Lehiste (1960) who considered acoustic information to be of prime importance and who found that adult subjects could distinguish between members of phonetically ambiguous pairs in both sentence context and isolation. Hoard (1966) excised ambiguities from continuous speech samples and presented the items with a list of alternatives to listeners. In over 50% of the cases, listeners were correct in their choice of what the speaker intended.

Because these opposite positions have received some empirical support, it is likely, as Marslen-Wilson et al. (1978) pointed out, that some combination of the two levels is likely to be involved in disambiguation. Liberman (1963), Morton (1966) and Thorne (1966) have developed this position.

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 understand the intended message. The concept of redundancy is based upon the fact that given the first few words of a sequence, the listener can predict the next word with some real probability of being correct. Thus, 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 hypothesized within a sentence, the more redundant is that sentence; low percentages imply nonredundancy (Clark & Clark, 1977).

Liberman embedded words into redundant and nonredundant sentence contexts. Then, he excised the words from the sentences and discovered that the acoustic analysis of the excised words revealed 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 (semantic, syntactic) come into conflict, the higher-level processes would resolve ambiguity to a greater degree than would the acoustic level. In order 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 proposition 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.

The above work lead Spencer and Wollman (1980) to extend Lieberman's 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 (e.g., "He had a name/an aim which was unusual") (Spencer et al., 1980, p. 173). Also, they raised the level of disambiguating context to prose (e.g., a short story about someone with an unusual aim). They reasoned that 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 members, the influences on perception from the next higher level of analysis (i.e., prose) could be tested. These researchers expected that pair members produced as isolated words would be the most accurately discriminated because there was no context to bias perception. Therefore, they expected that the more context present, the more difficult it would be to distinguish pair members, with prose providing the most difficult condition. Surprisingly, the results revealed that this was not the case. Even in the isolate condition, listeners had great difficulty in detecting pair members. Further, when they did hear a pair member, they did not hear the other member in any condition of context.

In an effort to investigate the cause of these unexpected results, Spencer et al. (1980) conducted a second experiment. Here, production of the pairs was recorded in three conditions: stories read fluently, individual sentences read fluently, and one and two word items read. The 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 the item <u>both ought</u> included "Bertha," "per heart," "their fault," and "favor." Only 3% of the incorrect answers were of other pair members. Listeners could fairly well identify the control items in all conditions except when excised from fluent speech. These misperceptions were phonetically related to the items. For example, responses for <u>praised it</u> included "praise him," "raised them," and "praise did." Spencer et al. attributed the difference in perceptual accuracy between ambiguous and control items as being due to phonetic ambiguities providing a poorer acoustical support for lexical access than do the control words.

Spencer et al. concluded that the nature of the listener's difficulties with speech perception were not difficulties in determining which pair member had been presented. Rather, they speculated that the listeners had no expectations of what the stimuli would be.

In order to find out why one form tended to be 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 detecting the ambiguities, and they responded with a wide variety of answers. When they did perceive a member, it was discovered to be the more salient (i.e., more familiar) pair member and was written more frequently than the less salient member. This was true 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 reversal of ambiguities easy to accomplish. Thus, pre-exposure (i.e., priming) to the ambiguities seems to increase phonemic awareness; it has a strong influence on listeners' ability to identify these ambigutiesin 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 demonstrated influences perception.

In order to explore, further, this avenue of study, Spencer and E. Carter (1982) conducted an investigation in which they varied context, familiarity, and priming. The new study varied context through embedding each member of each pair into three types of context sentences: those biased toward the other member, and those of netural 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.

The 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 rather than in the no priming condition. Also, of note is that there were fewer "wrong" responses in the priming condition. A response was determined to be 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.

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.

Unfortunately, there is, currently, very little research evidence available which is concerned with the nature of the development of phonetic perception in fluent speech. Shultz and Pilon (1973) have 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 et al. (1978) have criticized Shultz et al.'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 of "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 difference in type 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).

E. Carter and Zoller (1983) investigated the phonetic ambiguity perception of 4- and 5-year olds employing the isolate conditions outlined in Spencer et al. (1982). And, they manipulated the factors derived from Spencer et al.'s work: familiarity and expectation. Because of the age of the subjects, only 36 of the original 89 items from the Spencer et al. tape were presented. Within this age group, pilot testing revealed that it was feasible to use five morpheme boundary ambiguities, one phonological ambiguity, and nine control words (see Appendix 5). Also, because of the ages of the subjects, they could not be expected to write their responses. Therefore, they were presented with line drawings which visually represented the items. They were instructed to repeat what they heard and to point to the drawing which best represented the heard item.

Compared on the 36 items, the correct response mean scores were lower for the children than the adults. Yet, there were strong similarities. As with the Spencer et al. results with adults, the E. Carter et al. (1983) results indicated that phonetic ambiguity perception in the younger group was significantly facilitated when expectations concerning the identity of these items had been induced by priming.

Rationale for the Present Study

As outlined above, the literature is replete with examples of RD students' language problems. Observations of their delayed speech acquisition, difficulty in learning phonics, and poor memory for linguistic material are common. Primarily based upon the difficulties

RD students have in learning SSC rules and the results of phonemic confusability research with young RD and NRD students, several theorists have concluded that there are reading group differences in phonetic coding (e.g., I. Liberman et al., 1977; Shankweiler et al., 1979).

Reminiscent of Wepman's original idea is one recent speculation that RD students have greater difficulty than do NRD counterparts in their ability to decode speech (e.g., Brady et al., 1983; Godfrey et al., 1981). The results of these two studies are supportive of reading group differences, especially when the speech signal was distorted (by white noise). Given the ambiguous nature of continuous speech (and that used in the current study, particularly) and given the results of previous phonetic memory tasks, disabled readers are expected to compare unfavorably with non-disabled controls.

The present study employs four groups of subjects (reading disabled adolescent and elementary and non-disabled adolescent and elementary groups). The adolescents were included because the clinical literature indicates that older children and adolescents may have problems with oral language (expression and interpretation) that have continued (in a milder form) for many years. Yet, the persistence of phonetic coding in the older student has come into question recently (e.g., Johnston, 1983; Siegel, 1985). Because young reading groups have consistently been shown to differ (favoring the non-disabled), some form of compensation may be involved. Conrad's (1971) cross sectional findings point to a gradual improvement in phonetic coding in the elementary school years. To test the possibility that speech coding differences may be attributable to a developmental lag explanation, simply comparing age-mates would not be sufficient. Thus, a group of younger (elementary age) non-disabled readers are included, as well--with both groups expected to perceive less accurately than non-disabled adolescents. The last group, elementary-aged disabled readers, are included because of the possibility that the adolescents do not differ from one another. If an explanation of compensation is to be considered seriously, then it must first be established that these children have a problem. The young RD age-mates are expected to perceive less well than their non-disabled age-mates because of the previous perception research results (e.g., Brady et al., 1983) and because of the strength of the reading group differences in phonemic confusability under aural as well as visual modes of stimulus presentation (e.g., Mark et al., 1977; Shankweiler et al., 1979).

In addition to determining whether the groups simply differ in their perceptual accuracy, this investigation also focuses on the "how" question. For the condition of word form, the control words should be the easiest for the non-disabled students to identify, followed in difficulty by the familiar and rare ambiguity items. This hypothesis was derived from the previous work with preschoolers and adults (e.g., Carter et al., 1983; Spencer et al., 1982). Based upon the results of the same studies, priming should facilitate identification of the ambiguities.

Due to the lack of studies with RD students, it is difficult to anticipate exactly how the groups may differ. However, because of work within the SSC vein and available speech perception studies, RD students are hypothesized to have particular difficulty with phonetic ambiguity perception. Because priming has been shown to influence such perception, RD subjects' use of the information that priming provides for perceptual integration may be expected to be less efficient than NRD counterparts. Based upon this reasoning, the effect of priming is hypothesized not to be as great for the RD as for the NRD students. Because of the difficulty even NRD adults (Spencer et al.) have in perceiving rare ambiguities, no difference in the order of word form difficulty (i.e., control, familiar, rare) should occur. Therefore, the current hypothesis is that rare ambiguity forms should provide extreme difficulty for the RD students when attempting to decode speech, moreso than for NRD subjects. Further, the frequent word forms were expected to be more difficult than the control items, even moreso for the RD than NRD subjects.

Method

Subjects

A total of 90 English-speaking students from the Richmond, Virginia metropolitan area served as subjects. The first group was composed of 32 male (N = 26) and female (N = 6) adolescents (12 years, 9 months to 18 years, 9 months) who attended a local private school for reading disabled adolescents (ARD). The second group of 22 subjects (11 males, 11 females) was composed of approximate age-mates (14 years, 2 months to 18 years, 1 month) with no diagnosed reaing problems (ANRD--adolescent, non-disabled readers). They attended a local private high school. The third group was comprised of 22 students with no diagnosed reading problems and who attended a local private elementary school (ENRD--elementary school aged non-disabled students). These students, 7 males and 15 females, ranged in age from 5 years, 2 months to 13 years, 1 month. The fourth group (elementary school aged reading disabled--ERD--students) was composed of 14 male (N = 8) and female (N = 6) 2nd to 6th graders diagnosed as reading disabled. They attended Virginia Commonwealth University's Reading and Child Study Center and Riverside School, a local private school for learning disabled elementary school students. They ranged in age from 8 years, 5 months to 11 years, 8 months. All four groups were composed of middle to upper-middle socioeconomic backgrounds.

The disabled groups in this study were defined as such according to their word-decoding abilities. School administrators characterized the ARD group as being 2 years or more behind age-mates in word decoding skills. For the ARD students, Wide Range Achievement Test (WRAT) and Gray Oral Reading scores were taken into consideration. The ARD subjects' WISC-R scaled scores were 85 or above (Full-scale, Vocabulary, and Performance). The ERD group was comprised of members selected by the Reading and Child Study Center administrators according to scores on the Woodcock-Johnson Achievement Test, WRAT and WISC-R scores.

Within the ARD group, 16 subjects were assigned, through coin toss, to each condition, (i.e., priming or no priming). Similarly within the ANRD group, 11 subjects were assigned to each condition, respectively. Ten children were assigned to the no priming and 12 were assigned to the priming condition, within the ENRD group. Seven children in the ERD group were respective assigned to the priming conditions. One child within the ENRD group had to eliminated from the study due to equipment problems.

Two psychology undergraduates, one female (age 21) and one male (age 22), served voluntarily as raters. Both were of middle socioeconomic status.

Materials

An Identification Audiometry was performed to screen subject candidates who might have had hearing impairment--not to establish exact thresholds. For this purpose, a Lafayette 1977 Belton 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 have 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 provided by Spencer of Virginia Commonwealth University. It is comprised of 89 items--isolated words and phrases excised from sentences (read by a male native English speaker). It is one of the recordings used in the Spencer et al. (1982) study. Because of the age of the youngest subject (5 years, 2 months), as in the Carter et al. (1983) study, only 36 of the items were used in the present study (see Appendix 5). Instead of simply tape recording the 36 needed items from the 89 in the Spencer et al. tape, an attempt was made to maintain the fidelity of the presentations made in that study. Thus, the experimenter used the original tape and determined the locations of the needed items (i.e., in tape player revolution numbers). The tape was never removed from the player throughout testing, this allowed the experimenter 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. However, no subject had to wait any longer than 30 s between items.

In order to account for possible effects due to the differences in sound intensity of the various items, the experimenter measured their sound intensity in db SPL (i.e., decibels re: .0002 dynes/cm^2) in each of the environments provided for testing. To accomplish this a Bruel & Kjaer 2215 Precision Sound Level Meter Octave Analyzer, A

Scale, was used.

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 and were placed approximately 63 cm apart in each testing.

Because many RD students also tend to have difficulty with writing, line drawings were used to represent each item visually. They are illustrated in Appendix 8. For each item presented, the experimenter placed a sheet (8 1/2 x 11 in) in front of the subject on a table. Because the WISC-R has revealed that the memory capcity of 5-year-olds is sufficient to handle six items, each sheet 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 sheet. (See Sample Picture Sheet in Appendix 8.) When assembling the sheets, the selection of which items would occupy which locations was specified as follows: the experimenter randomly assigned, through die toss, the correct item to one of the six positions. The corresponding pair member was placed to the left or right of that item. The other two items were assigned in the same manner. For the orders of picture presentation used, see Appendix 9.

In order to record subject responses and to provide a means for testing inter-rater reliability, audio cassette tape recordings were made during each session. For this purpose a Realistic CTR-56 Cassette Recorder with condenser microphone, model number 14-1006 was employed. The recordings were stored on TDK Type D (i.e., for speech)

Precision Mechanism Cassette tapes.

Procedure

Each subject had to have the informed consent of parent or guardian. (See Appendix 3 for Informed Consent Letter.) The experimenter explained to each subject what he or she would be doing and answered any questions concerning his or her participation. Further, each subject was told that, at any time, he or she could stop for as long as necessary to rest, go to the restroom, etc. The experimenter also explained that if the subject simply did not want to participate or continue, he or she would not be required to do so. No testing session was interrupted or stopped. The only breat was dring a rest period always given between the audiometry and phonetic ambiguity test. This period lasted between 5 to 10 minutes. This gave the subject time to rest and the experimenter an opportunity to set up the equipment for the phonetic ambiguity test.

Identification audiometry. Each student was taken into a room the administrator deemed the quietest possible within the respective school's facilities. The audiometer was placed in front of the subject but not in a manner in which the subject could see when the control levers and dials were manipulated. (See Appendix 6 for the instructions given to each subject and the procedure used.) The entire audiometry procedure required approximately 5 to 10 minutes to complete.

Phonetic ambiguity test. If through the Audiometry the experimenter determined that the subject was capable of hearing the tape, the phonetic ambiguity test could procede. No subject was eliminated due to hearing problems. For each of the tested groups, the reel-to-reel tape player and accompanying speakers were located approximately 50 cm in front of the subject. The seat was not moved throughout the phonetic ambiguity test to insure that the subject had an optimal chance of clearly hearing all the items.

Under both exposure conditions, the participants listened to the item presented over the speakers and repeated what they heard loud enough for the cassette recorder to pick up. Also, they had to explain what the item was, and they marked with a pencil a picture which represented the item.

For the no priming condition, the experimenter used the following instructions:

> 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 what he said. Say it loud so that I can hear you. Then I'll ask you what it means. If you see a picture on the sheet of what he said, mark it with the pencil. We'll go through several words. Then, we'll be finished.

Then, the experimenter questioned the subject by inquiring: "If the man says gasoline, what do you say?" The participant was then asked what it was and to point to a picture if he or she saw one of it. All of the participants recognized gasoline and could select the appropriate picture. Once actual testing began, the experimenter gave no explanation for an item not understood. However, the experimenter did give explanations after the session for any item not understood. But during testing if the participant did not understand an item, the experimenter said to him or her "that's O.K.; you're doing fine."

Then the experimenter presented the next item.

Under the priming condition, the experimenter gave the above instructions and followed the same procedure. However, the subjects in this condition were first "primed" by being pre-exposed to the phonetic ambiguity pairs. For each pair, the experimenter placed the drawings of the ambiguity pair members side-by-side in front of the participant, one pair at a time. Then, the experimenter pointed to one of them and said the item. For example, when pointing to the picture of a heart, the experimenter said "this one is sweetheart." Then the subject was asked to repeat the item and explain what it meant. The same was done with the other pair member. When the child affirmed, the experimenter again asked what the item meant. Testing began only after the subject could explain the meaning of each primed item.

In order to make their judgment about what the subject intended as a response, the raters listened to a tape recording of the subject's oral response and took note of the picture he or she chose. One rater identified all the subjects' responses. Both raters were allowed to replay the tape until she or he was sure of what the subject said. Both were allowed to rely on the picture selection to resolve any uncertainty. Judgments for each item were recorded on the Phonetic Ambiguity Response Sheet (see Appendix 10).

Inter-rater reliability. Using a rater to obtain response measures is inherently subjective. Thus, a second rater was asked to identify the responses of nine randomly drawn subjects, three each from the first three groups. His judgments were compared with those of the first rater.

Inter-rater reliability is the number of agreements divided by the number of agreements plus disagreements. In this study, agreement was defined as both raters recording the same words or sequence of sounds (when the subject spoke a nonword--e.g., "bossa") and meanings. The inter-rater reliability was 98.76%.

Sound intensities. In each of the testing locations, the sound level meter was placed approximately mid-way between the two speakers and approximately 50 cm from the tape player. Ambient noise levels were recorded for each location. In order to control for measurement error, the experimenter recorded the arithmetic mean of three peak intensity measurements made for each item. The results are listed in Appendix 7.

Results

Contained in Table 4 are the mean number correct scores for subject groupings in each condition of priming (priming or no priming) and word form (control items and rare and frequent phonetic ambiguity items). Comparable mean number other scores are summarized in Table 5. To determine if the means were statistically significant, two split-plot 2 (priming) x 3 (word form) x 2 (reading level: disabled, non-disabled) x 2 (age group: adolescent, elementary) Analysis of Variance tests (ANOVAs) were conducted. Each ANOVA employed either number correct or number other phonetic ambiguity items as the dependent variable.

ANOVA with Number Correct as Dependent Measure

A response was considered 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. The summary for this ANOVA is presented in Table 6.

The main effect of priming was found to be significant (F (1, 82) = 49.53, p. < .0001). Those subjects who were primed to the phonetic ambiguity pairs prior to testing responded correctly to significantly more of both phonetic ambiguity and control items than did those

Table 4

Mean Number Correct Scores with Standard Deviations

by Priming Condition, Word Form and Subject Group

		Priming Condition					
		No Priming			Priming		
Word Form:		Control	Familiar	Rare	Control	Familiar	Rare
Group							
ARD	M	11.88	8.88	5.56	11.94	8.56	8.83
	SD	1.45	1.26	1.34	0.25	1.75	1.54
			n = 16			n = 16	
ERD	M	11.57	7.43	3.43	11.94	8.56	8.63
	SD	1.13	1.13	1.62	0.77	1.25	2.32
			n = 7			n = 7	
ANRD	M	12.00	7.80	3.43	11.71	9.71	7.14
	SD	0.08	2.74	1.67	0.28	1.11	2.81
			n = 10			n = 12	
ENRD	M	11.64	7.36	4.82	11.00	9.81	6.81
	SD	0.67	2.20	1.17	0.77	1.25	2.32
			n = 11			n = 11	

Note. ARD = adolescent reading disabled; ERD = elementary reading disabled; ANRD = adolescent non-disabled; ENRD = elementary non-disabled.

Table 5

Mean Number "Other" Scores with Standard Deviations by Priming Condition, Word Form and Subject Group

		Priming Condition			
		No Priming		Priming	
Word Form:		Familiar	Rare	Familiar	Rare
Group					
ARD	M	3.06	2.94	0.94	4.56
	SD	1.06	1.41	1.53	1.57
		n = 16		n = 16	
ERD	M	2.00	4.71	1.29	5.71
	SD	0.76	1.60	1.63	2.14
		n = 7		n = 7	
ANRD	M	2.67	3.08	1.50	4.40
	SD	1.35	1.90	1.50	2.15
		n = 10		n = 12	
ENRD	M	1.45	4.36	2.27	5.18
	SD	1.42	1.72	0.93	2.54
		n = 11		n = 11	

Note. ARD = adolescent reading disabled; ERD = elementary reading disabled; ANRD = adolescent non-disabled; ENRD = elementary non-disabled.

Table 6

Summary Table for the Split-Plot ANOVA on the

Number of Correct Responses: All Levels of Word Form

Source	SS	df	F	p
Priming	127.39	1	49.53	< .0001
Reading Level	0.38	1	0.15	< .7021
Reading Level x Priming	0.16	1	0.06	< .8014
Age Group	21.27	1	8.27	< .0051
Age Group x Priming	3.08	1	1.20	< .2768
Age Group x Reading Level	1.45	1	0.56	< .4555
Age Group x Priming x Reading Level	6.75	1	2.62	< .1092
Error (Subject (Priming x Reading Level x Age Group))	210.88	82		
Word Form	1246.69	2	251.04	< .0001
Word Form x Priming	106.25	2	21.39	< .0001
Word Form x Reading Level	0.96	2	0.19	< .8286
Word Form x Age Group	21.77	2	4.83	< .0140
Word Form x Priming x Reading Level	5.97	2	1.20	< .3031
Word Form x Priming x Age Group	18.93	2	3.81	< .0241
Word Form x Reading Level x Age Group	4.14	2	0.83	< .4363
Word Form x Priming x Reading Level x Age Group	1.52	2	0.31	< .7359
Error (Subject x Word Form (Priming x Reading Level x Age Group))	407.22	164		
Total	2184.79	269		

Note. A General Linear Models analysis was employed when performing the ANOVA due to the unbalanced number of subjects per reading level and age groupings and of priming conditions.

subjects not primed. ($\bar{X}$ = 9.55 and $\bar{X}$ = 7.98, respectively, S.D. = 2.67).

The mean number correct was also found to be significantly different for each age group (F (1, 82) = 8.27, p. < .0051). The adolescents responded with more correct identifications than did the elementary aged subjects ($\bar{X}$ = 9.0 and $\bar{X}$ = 8.6, respectively, S.D. = 2.88). There was no significant interaction between age and reading level, between age and priming, or between all three factors.

There was a significant difference between the three types of word form (F (2, 164) = 251.04, p. < .0001). A Turkey post hoc analysis revealed that all three word forms were significantly different at a .05 level of confidence (control: $\bar{X}$ = 11.71; frequent: $\bar{X}$ = 8.52; rare: $\bar{X}$ = 6.08). The interaction of word form and priming effects was also significant (F (2, 164) = 21.39, p. < .0001). This relationship is illustrated in Figure 1. Under the priming condition identification of both rare and frequent ambiguity items improved, with frequent items favored. For control words there was little difference. There was a significant interaction between word form and age group (F (2, 164) = 4.83, p. < .0140). There was little difference due to age group for the control items, but the adolescents consistently performed better than the elementary students on the ambiguity items (See Figure 2).

The second order interaction of word form x priming x age group was also significant (F (2, 164) = 3.81, p. < .0241). From an examination of Figure 3 one can see that all groups performed similarly on control items. However, primed subjects, whether adolescent or elementary aged, correctly identified more frequent than

Figure 1
Number Correct for All Subjects as a Function of Word Form and Priming

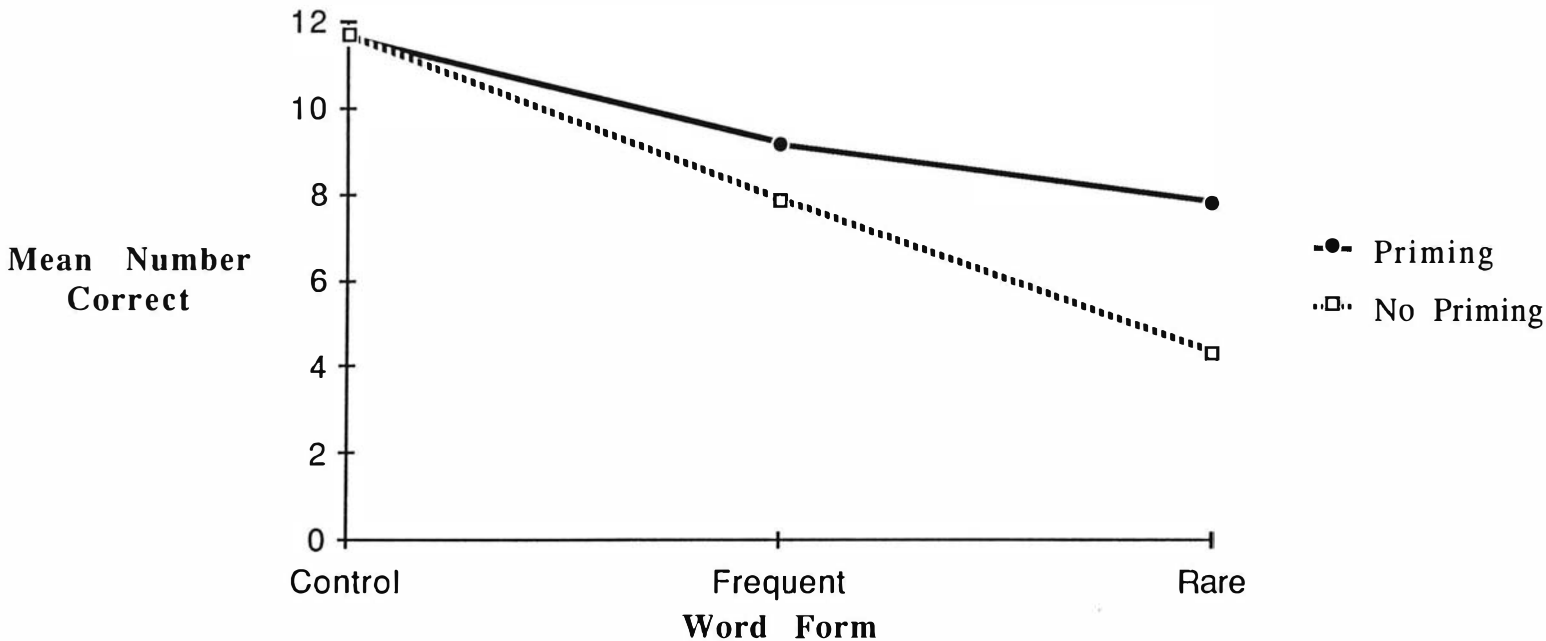


Figure 2
Number Correct for Elementary and Adolescent Age Groups as a Function of Word Form

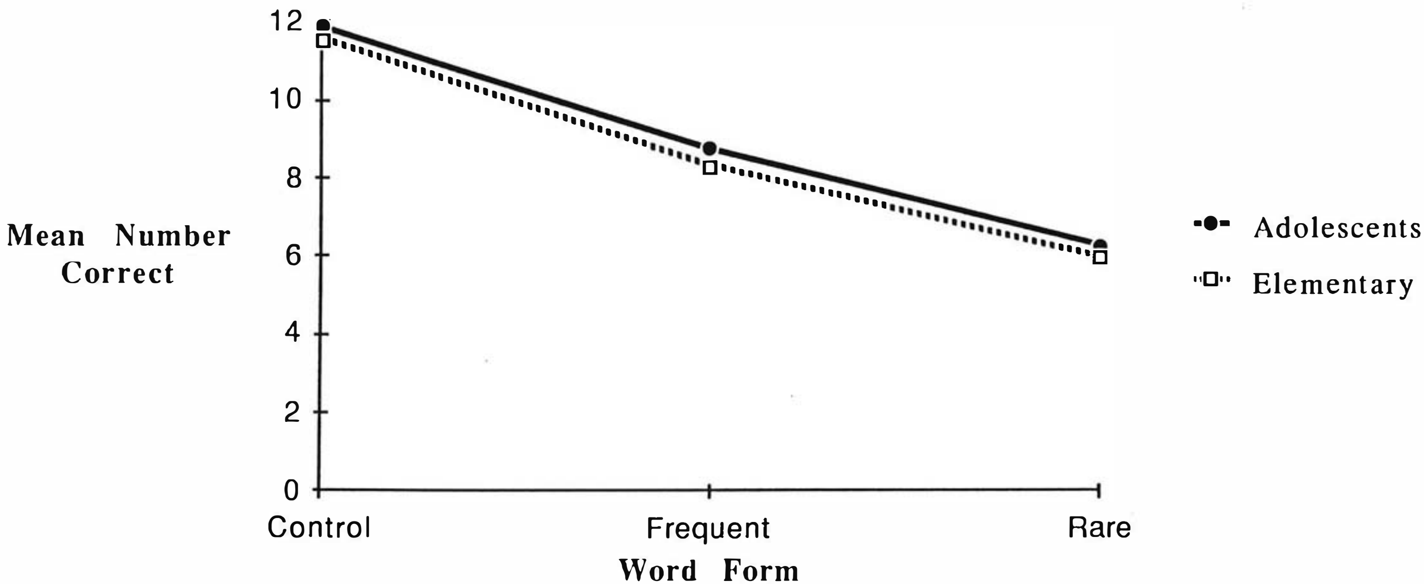
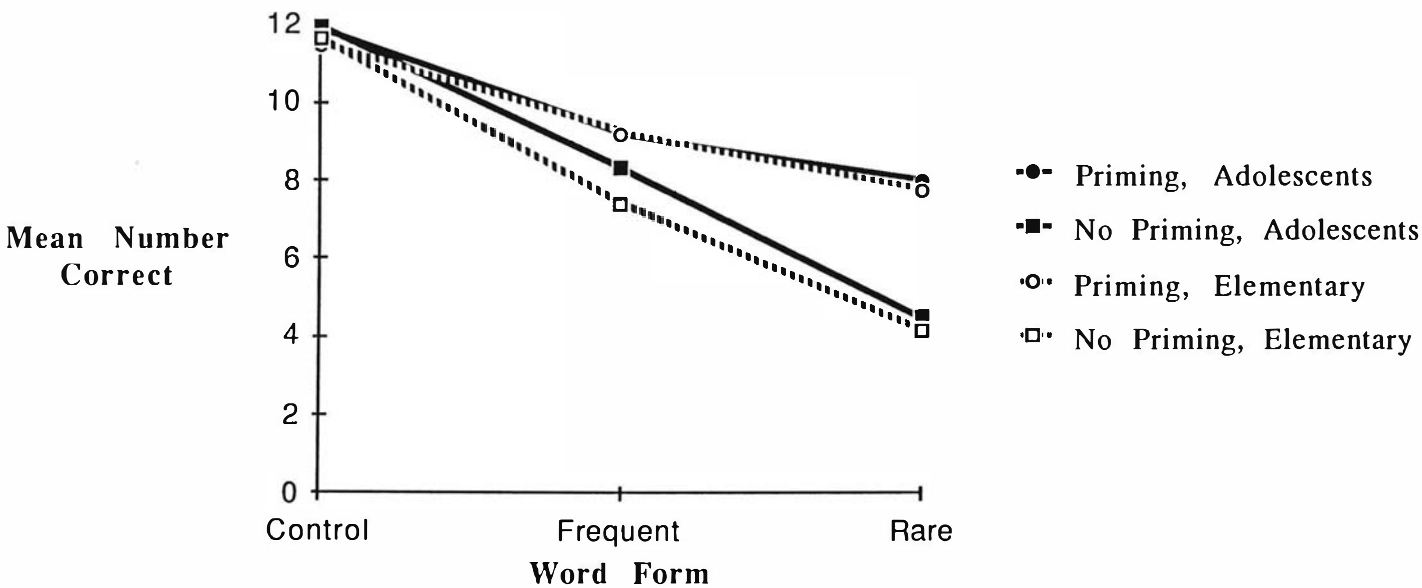


Figure 3
Number Correct for Elementary and Adolescent Age Groups as a Function of Word Form and Priming



rare items and did so more than did either age group when not primed. Under the no priming condition, the adolescents performed better than the younger students on the familiar ambiguity items. But, this relationship did not hold for rare ambiguity items.

There was no significant main effect due to reading level nor to any of its interactions, including third order interaction of word form x priming x reading level x age group.

As was expected, the control items were easily identified by all groups of subjects. A follow-up to the above ANOVA was done by deleting the control items from analysis to determine if the significant interactions were indeed attributable to differences between ambiguity items. Table 7 shows the summary table for this ANOVA. The same factors which were significant in the previous ANOVA were also significant in this analysis as well: priming (F (1, 82) = 55.43, p. < .0001), word form (F (1, 82) = 61.90, p. < .0001), age group (F (1, 82) = 4.81, p. < .0312), word form x priming (F (1, 82) = 8.50, p. < .0046), word form x age group (F (1, 82) = 5.95, p. < .0169), word form x priming x age group (F (1, 82) = 4.29, p. < .0414).

ANOVA with Number Other as Dependent Measure

As in previous phonetic ambiguity studies,the subjects from all the groups often responded with the alternate (or "other") member when a phonetic ambiguity item was presented. A separate analysis using the occurrence of the other member as the dependent variable is presented in Table 8.

The priming effect was not significant.

The performance of the two age groups was significantly different

Table 7

Summary Table for the Split-Plot ANOVA on the

Number of Correct Responses: Ambiguous Word Forms Only

Source	SS	df	F	p
Priming	202.96	1	55.43	< .0001
Reading Level	0.10	1	0.03	< .8677
Reading Level x Priming	0.06	1	0.02	< .9004
Age Group	17.60	1	4.81	< .0312
Age Group x Priming	6.41	1	1.75	< .1893
Age Group x Reading Level	4.32	1	1.18	< .2805
Age Group x Priming x Reading Level	7.07	1	1.95	< .1663
Error (Subject (Priming x Reading Level x Age Group))	300.27	82		
Word Form	220.83	1	61.90	< .0001
Word Form x Priming	30.32	1	8.50	< .0046
Word Form x Reading Level	0.84	1	0.23	< .6298
Word Form x Age Group	21.22	1	5.95	< .0169
Word Form x Priming x Reading Level	4.99	1	1.40	< .2402
Word Form x Priming x Age Group	15.31	1	4.29	< .0414
Word Form x Reading Level x Age Group	.53	1	0.15	< .7007
Word Form x Priming x Reading Level x Age Group	.61	1	0.17	< .6797
Error (Subject x Word Form (Priming x Reading Level x Age Group))	292.54	82		
Total	1125.98	179		

Note. A General Linear Models analysis was employed when performing the ANOVA due to the unbalanced number of subjects per reading level and age groupings of priming conditions.

Table 8

Summary Table for the Split-Plot ANOVA on the

Number of "Other" Responses

Source	SS	df	F	p
Priming	161.26	1	.89	< .3481
Reading Level	0.05	1	0.03	< .8639
Reading Level x Priming	2.57	1	1.42	< .2374
Age Group	9.47	1	5.23	< .0248
Age Group x Priming	3.34	1	1.84	< .1782
Age Group x Reading Level	.23	1	.13	< .7245
Age Group x Priming x Reading Level	.32	1	.17	< .6770
Error (Subject (Priming x Reading Level x Age Group))	148.24	82		
Word Form	252.39	1	73.88	< .0001
Word Form x Priming	41.28	1	12.08	< .0008
Word Form x Reading Level	1.45	1	0.43	< .5161
Word Form x Age Group	21.22	1	5.95	< .0169
Word Form x Priming x Reading Level	5.74	1	1.68	< .1987
Word Form x Priming x Age Group	13.18	1	3.86	< .0529
Word Form x Reading Level x Age Group	.84	1	0.25	< .6217
Word Form x Priming x Reading Level x Age Group	.13	1	0.04	< .8463
Error (Subject x Word Form (Priming x Reading Level x Age Group))	280.14	82		
Total	944.98	179		

Note. A General Linear Models analysis was employed when performing the ANOVA due to the unbalanced number of subjects per reading level and age groupings and of priming conditions.

($\underline{F}$ (1, 82) = 5.23, $\underline{p}$. < .0248). The elementary aged subjects made more reversals than did the adolescents ($\bar{X}$ = 3.37 and $\bar{X}$ = 2.89, respectively, S.D. = 2.12).

Word form was also a significant effect ($\underline{F}$ (1, 82) = 73.88, $\underline{p}$. < .0001). Alternate responses occurred more often when rare items were presented than when frequent items were ($\bar{X}$ = 4.37 and $\bar{X}$ = 1.90, respectively, S.D. = 1.86). The interaction of word form and priming was significant. This interaction is depicted in Figure 4. Subjects made more reversals under both priming conditions when presented rare items; however, this trend was stronger when subjects were primed. For the frequent items, more reversals occurred under the no priming condition. Word form x age group was also a significant interaction. It is illustrated in Figure 5. Both age groups chose the alternate member more when presented with rare than frequent items. This effect was stronger for the elementary students than for the adolescents. However, the adolescents made more reversals than did the elementary students when presented with frequent items.

There was a significant second order interaction of word form x priming x age group ($\underline{F}$ (1, 82) = 3.36, $\underline{p}$. < .0529). Figure 6 reveals that there was a greater tendency for reversals when rare items rather than frequent items are presented for all subjects. The smallest difference occurs for the non-primed adolescents and the greatest for the non-primed elementary students.

<u>Sound Intensity Levels</u>

To determine if there was any relationship between the dependent variables and sound intensity levels of the presented items, eight Pearson Product Moment Correlation were calculated for each subject

Figure 4
Number Other for All Subjects
as a Function of Word Form and Priming

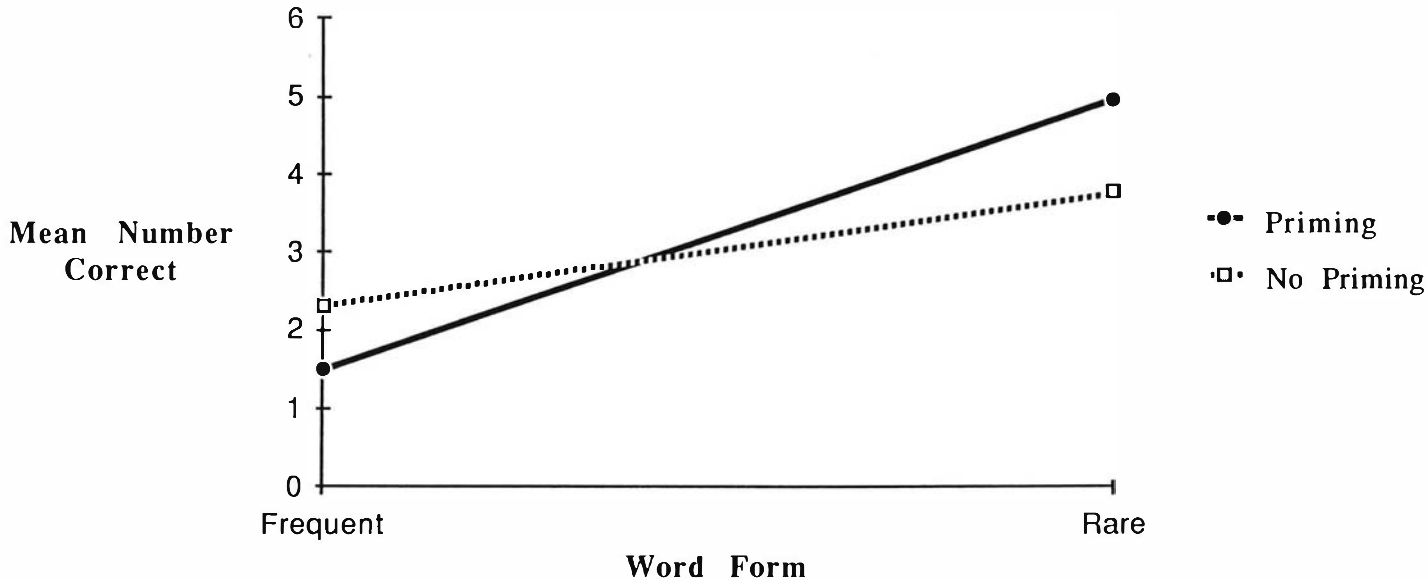


Figure 5
Number Other for Elementary and Adolescent Age Groups as a Function of Word Form

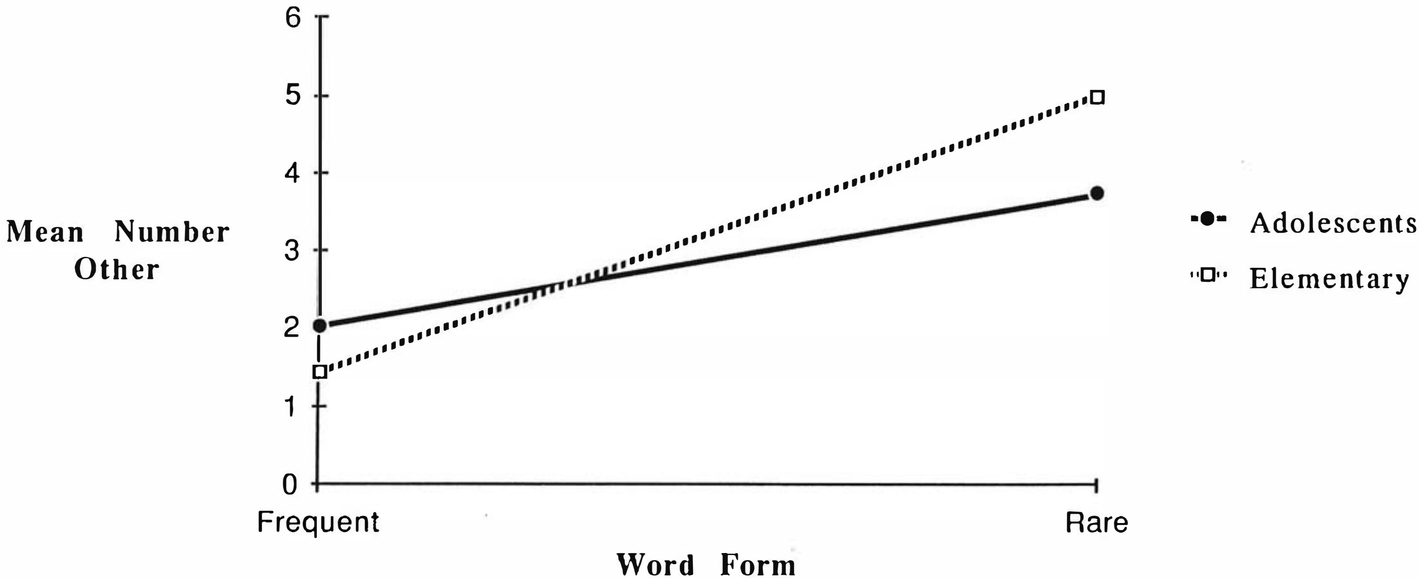
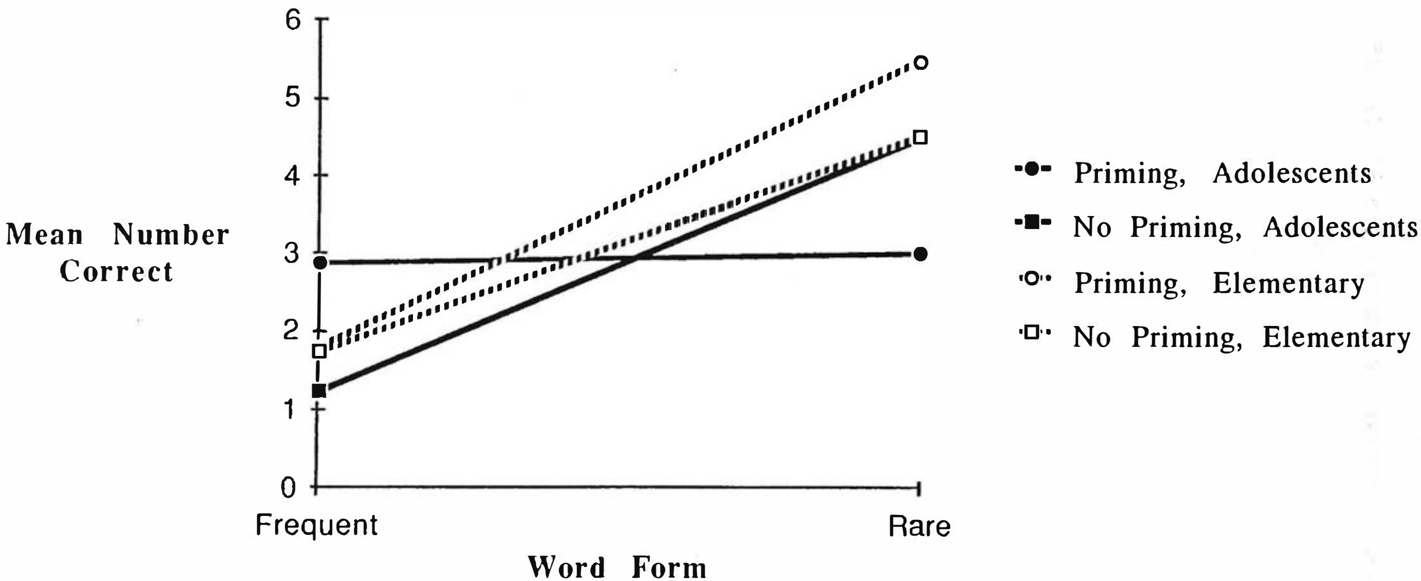


Figure 6
Number Other for Elementary and Adolescent Age Groups as a Function of Word Form and Priming



group. The results are shown in Table 9. All correlations were too low to reflect any significant relationship between sound intensity level and either of the dependent measures. A Coefficient of Determination of the highest correlation (r = .05) indicated that 99.75% of the variance in this experiment was due to sources other than the sound level of the items.

Item Analyses

As a qualitative comparison of the groups, an item analysis of their responses was performed concerning the number and percentage of items they correctly identified, identified as the alternate item, and identified as incorrect (not including "other" responses). Taking into account both initial and repeat presentations, a rank ordering of these responses for phonetic ambiguity members was performed. For all groups of subjects, both ought proved the most difficult to identify. Across all groups it resulted in a variety of nonword responses such as "bossa," "botho," and "Bo's foot." Sweetheart engendered the most correct responses for all groups. Then writer and rider were the items most to be reversed for all groups. Upon visual inspection there was no discernable difference in the types of incorrect responses made by any of the groups. Nonword responses tended to share phonemic similarity with the presented item. For example, "eh neh," "a neeyeh," and "aning" were typical responses to an aim and "m'cry," "mc rye" for may cry. The real word incorrect responses included: marker for market and me cry, make right, and make rise for make rye, and Bo's salt and bullfrog for both ought.

Table 9

Pearson Product Moment Correlations Between Sound Levels and the Dependent Variables for Each Subject Group

	Groups			
	ARD	ERD	ANRD	ENRD
Dependent Variable				
Number Correct	.040	.001	.050	.100
Number Other	.010	-.012	.002	.006

Note. ARD = adolescent reading disabled;
ERD = elementary reading disabled;
ANRD = adolescent non-disabled;
ENRD = elementary non-disabled.

Discussion

Design Considerations

The general assumption underlying the present study is the SSC position that the problem many disabled readers have in decoding written words may be due to an insensitivity to the phonetic form of language. Of direct relevance to the present study is the shared assumption that this insensitivity may have its roots in a speech perception deficit. (See I. Liberman et al., 1979; Brady et al., 1983; Godfrey et al., 1981.) One aim of the current study was to determine if there were reading group differences in the identifications of words and phrases taken from continuous speech Continuous speech was employed because, unlike discontinuous speech signals, it is what is typically encountered in the class.

However, even repeated findings of reading group differences, alone, cannot provide information about how the speech perception processes may differ between reading groups. Therefore, the design of this study was formulated not only to compare reading groups in terms of perceptual accuracy (Brady et al., 1983; Godfrey et al. 1981) but to determine how the groups differ in their perceptions of phonetically ambiguous continuous speech (as a function of word form and priming). (See Spencer et al., 1980, 1982.)

In addition to the above issues (i.e., if there is a difference between groups and how they may differ), there are developmental questions. Phonetic coding research which compared early elementary-aged RD versus NRD students consistently showed that RD youngsters did not use phonetic coding to retain verbal information while NRD youngsters did. When older children were compared, however, this difference between reading groups was not found or was found to be mildly reversed. This difference between the reading group comparisons of younger and of older students, the scarcity of research dealing with the development of phonetic coding in normal school-aged children (Conrad, 1971), and the issue of speech perception underlying phonetic coding all lead to the development of the current study's design. Unlike the design most commonly used, which simply includes two groups (RD and NRD age-mates), the present design also provides for comparisons between age groups and between age group by reading group combinations by including both adolescent and elementary disabled and non-disabled readers. Such a design is essential to answering the issue of compensation with age, particularly when examining the validity of a developmental lag explanation (e.g., see Siegel, 1985). Specifically, if older RD students are believed to differ from age-mates in that they are on a slower course of normal development, then their performance must be compared with younger reading level controls as well as age-mates.

Explanation of Results: Discrepancies with Other Studies

Despite the theoretical arguments for a deficit in speech perception and contrary to the results of the other relevant speech perception research (i.e., Brady et al., 1983; Godfrey et al., 1981), the current data reveal no significant difference in accuracy between reading groups. Further, there is no reading group difference as to how they decode the phonetically ambiguous speech in terms of priming or word form factors. Whether they were primed or not, both RD and NRD subjects of adolescent or elementary-aged were equally facile in identifying items. Also, the disabled readers, like non-disabled counterparts, found frequent items easier to identify than rare items and control items easier than ambiguous ones.

Why did the other speech perception comparisons result in reading group differences while the current study did not? An answer may lie in the quality of speech signal presented to the subjects in each study--perhaps resulting in sufficiently different listening conditions.

In the first study, Godfrey et al., (1981) did not employ naturally occurring speech. They believed the speech perception differences between groups would be subtle, so they wanted precise control over the stimulus. They explored reading group differences in phonemic categorical perception by adjusting acoustic cues (formants) presented via speech synthesizer. This is a widely accepted technique for examining categorical perception. (See H. Clark et al., 1977.) However, ecological validity of the results of such methods is questionable. The general premise is that RD students have difficulty learning SSC rules because they do not perceive speech correctly. Given this, then the most appropriate type of speech to employ as a stimulus when testing for reading group differences should be as similar as possible to that spoken in classrooms. Thus, the results of any study which shares this SSC premise must be fairly generalizable to classroom speech settings. Godfrey et al.'s results do not meet this criterion.

Although at this point speculation is in the main, the difference in choice of speech stimuli between that used in the current study and that of Godfrey and associates may account for the discrepancy between the results. The area of suprasegmental research is in its infancy, but an explanation invoking the differences in suprasegmental information between studies may be appropriate. For example, one possible drawback in using discontinuous speech such as that used in the Godfrey et al. study is that the suprasegmental information (e.g., intonation, stress) which occurs in the flow of natural conversational speech is unavailable to listeners. Such cues may provide acoustic information which is important in the decoding of speech. The current study presented words and phrases drawn from the flow of naturally produced, continuous speech, with the integrity of presentation preserved as best as possible. It is, thus, appropriate to conclude that at least some of the original suprasegmental information was available to the listeners. This speech signal may have provided some appropriate (albeit still unknown) suprasegmental information which was sufficient to allow the RD listener's perceptions to be on par with those of NRD subjects while Godfrey et al.'s disjointed speech did not.

In the second perceptual study, Brady et al. presented speech via human voice, and the items were drawn from read sentences. However, each item was always the last word in a sentence and the sentences were all read with neutral prosody. Of important note is that the group differences were <u>only</u> obtained when the items were masked by noise. The disabled readers had no difficulty deciphering the same stimuli under an unmasked listening condition. Thus again, the dfferences in perceptual accuracy between reading groups were only observed under listening conditions quite dissimilar to that routinely encountered in a classroom setting.

While the items in the present study were isolated words and phrases, the speaker used a normal conversational tone to read the sentences from which the items were drawn. Further, the items themselves were taken from differing positions in those sentences. This allowed for presentatios which varied stress, intonation, etc., unlike those always taken from the end of sentenes where th range of cues may be more limited. It may be that the former provides some suprasegmmental aspect that aids in identification--some aspect that is not available in the stimuli used by Brady et al.

Of course, the references to suprasegmental differences between the current study and that of Godfrey et al. and Brady et al. have not, as yet, been empirically substantiated. However, they do point to the practical importance of taking into consideration the various facets of the speech signal when one examines continuous speech perception processes.

The finding that there was no reading group by age group interaction nor any higher order interaction involving these two factors provides another point of contention with previous phonetic coding research. Specifically, the phonemic confusability studies repeatedly demonstrated that young elementary RD students did not use phonetic coding to retain verbal information, while NRD students did (e.g., I. Liberman et al., 1977; Mann et al., 1980). This group difference, however, was not obtained for adolescents (or was mildly reversed). To account for such change over age groups two compensation arguments have been offered in the literature (see Siegel, 1985; Olson et al., 1985). However, because there is no significant difference regarding reading by age group factors, these compensation arguments are moot with regard to the present study.

Given the phonemic confusability results, why should there be a lack of reading by age interaction in the current study (or any pertinent higher-order interaction)? The possibility that the task was too easy--that there is a ceiling effect--was considered. However, it must be discounted by the fact that there was a main effect of age. Perception was less accurate in both younger reading groups. Another possible explanation to account for the difference between the phonemic confusability results and those of the current study was also considered. The difference may involve a difference in the selection criteria used to define children as disabled readers. However, this is an unlikely possibility because the WRAT, WISC-R, and Gray Oral Reading Test (or comparable tests) were also used, singly or combined, in the majority of the phonemic confusability studies. The studies differing in criteria constituted only a remaining handful which employed teacher assessments. However, no matter the selection device, the phonemic confusability literature consistently reported differences in the elementary reading groups. Thus, this explanation also lacks support. A side note. While the intention of the current study was not to replicate Conrad's (1971) developmental phonemic confusability study, it, too, points to an improvement with age in the coding of the sounds of speech.

Explanation of Current Findings

The most parsimonious explanation of the lack of significant reading group differences (or any reading group interaction) is that the reading groups do not differ in their perception of continuous speech, at least as regards the factors of priming and word form. This conclusion is bolstered by the pervasiveness of the results. The lack of reading group differences according to accuracy and word form effects is persistent whether the responses were measured in terms of number correct or number of reversals. Even the qualitative assessment of examining the types of errors made by the different reading groups revealed no pattern which would indicate that disabled readers had any greater difficulty than did non-disabled subjects when deciphering the ambiguous stimuli. All the errors for all reading groups shared phonemic similarity with the target items.

As a further point of strength for the validity of the results was that all reading and age groupings were tested in the same manner with the same selection criteria for respective reading groups. One other point pertaining to internal validity must be discussed. Due to practical considerations, each subject group was tested at respective schools, entailing different testing locations (i.e., classrooms, conference rooms, and storage rooms) for each. However, as regards the ambient noise sound levels, the listening conditions for each testing location was almost identical (only 1 to 3 dBs apart) (see Appendix 7). Further, correlations calculated between each dependent variable and the sound level of each item for each subject group were extremely low. Thus in the current study, a difference in the sound level cannot be considered to have been a significant effect. Given each location, the listening conditions for each group may be assumed to be essentially the same.

General Conclusions

The most plausible explanation for the lack of significance associated with reading group or any of its interaction is that the phonetic coding problems or RD students are probably not due to speech perception deficit entailing phonetically ambiguous speech and the factors of priming and word form. This point is underscored by the fact that all the reading and age groups and combinations were tested under the same conditions, which involved continuous speech stimuli (to mimic the classroom speech setting). Further, the perception of the ambiguous items used had to turn on differences in the phonetic structure of the items. To emphasize the point further, the results of these RD (as well as NRD) subjects closely resemble the similarities of previous phonetic ambiguity studies, also employing the factors of priming and word form. For example, just as for adults in the Spencer et al. (1982) study and for preliterate preschoolers in the Carter et al., (1983) study, the main effects of word form and priming significantly affected correct identifications for all reading groups in the present investigation. Also, as in the previous studies, all reading groups responded with a significant majority of reversals being in the direction of the frequent form. Further, for all three studies, the influence of sound intensity was almost nil. Finally, the lack of significant priming effects when the number of alternate identifications is examined was also replicated.

Such findings clearly call into question the degree of continuous speech perception's effects on the word decoding skills of even young elementary RD students, not to mention the adolescents. Unless some other factors (still unknown) involved in decoding continuous speech are shown to clearly differentiate reading groups, one would do better to explore explanations other than those making reference to speech peception deficits (e.g., visual, serial order recall, see Vellutino, 1979). Even though there is evidence of speech perceptual differences between groups given by Brady et al., (1983) and Godfrey et al. (1981), thse differences pertain to an unnatural set of circumstances--unlikely to be found in the course of a reading lesson and, thus unlikely to be germane to the problem. Although the current author cautioned against Dykstra's (1966) pessimism with the auditory discrimination results, she finds herself having to take a similar stance with regard to the reading disabilities speech perception literature.

List of References

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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 priming condition--no difference between neutral and bias source tape

[c] Member presented

Appendix 3

Psychology Department
Virginia Commonwealth University
810 W. Franklin Street
Richmond, VA 23284-0001
Date

Dear Parents:

I am a doctoral candidate in the Experimental Psychology Program at Virginia Commonwealth University; my area of expertise is in the acquisition of the perception of and production of language. The research that I propose to do with your son or daughter will provide valuable insight into the speech perception processes in the reading disabled. This is an area that is, only now, beginning to be explored. And, I believe that the results of this study will provide important information of relevance, not only to basic research but to language skills instruction as well.

Selected reading disabled students who volunteer for the study will be asked to listen to an audiotape, to tell me what they here (response recorded on audio cassette tape), and to select a pictoral representation for each of 36 items. The task will take 20 to 30 minutes and will require only one session.

Reading test and WISC-R scores will be reviewed also and, as with the results of the present study, will be held in strictest confidence. If you would like to discuss any aspect of the study with me, please feel free to contactme at the above address of through the following telephone numbers: [redacted] (office) or [redacted] (home). You are free to withdraw your son or daughter from participation at any time.

If you consent for your son or daughter to participate in this study, please return this letter of consent to me. If you wish, a summary of the study will be available when the study is completed.

Thank you for your kind support.

Sincerely,

Elizabeth A. Carter

Signed:

Relationship to subject:

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. (NBM)

*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/a name which never missed the bullseye. (BR)
He had a name/an aim which was unusual. (NBM)

*6. They both thought about tha 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 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 (R)
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)

Because the Spencer and E. Carter (1982) tape contains more items than needed in the present study, the tape was fast forwarded over unused items.

Presentation Order of the Items Used in the
Spencer and E. Carter (1982) Study with Adult Subjects

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 subject hears the tone, mark the space with a check (✓).
If the subject 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 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 subject's understanding of the instructions can be tested. The investigator the presents the tone for approximately one second and asks the child to respond. Once the investigator is sure that the subject 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 subject is tested at 500 Hz, 1,000 Hz, and 4,000 Hz. These responses are recorded on the Hearing Acuity Response Sheet. If the subject passes all three frequencies, thent he ambiguity testing may begin. If the subject has impairment on any of the frequencies tested, the testing is discontinued. The investigator will not alarm the parent but will inform the parent that there is reason to believe that the child has some hearing impairment at the tested freuency(ies). If necessary, the parent will be taken through each step of the testing procedure by listening tothe tone at the decibel level(s) the child could hear and then at the criterion of 25dB. The parent will then be referred to the family physician or local health clinic for further information.

Appendix 7

Table 3

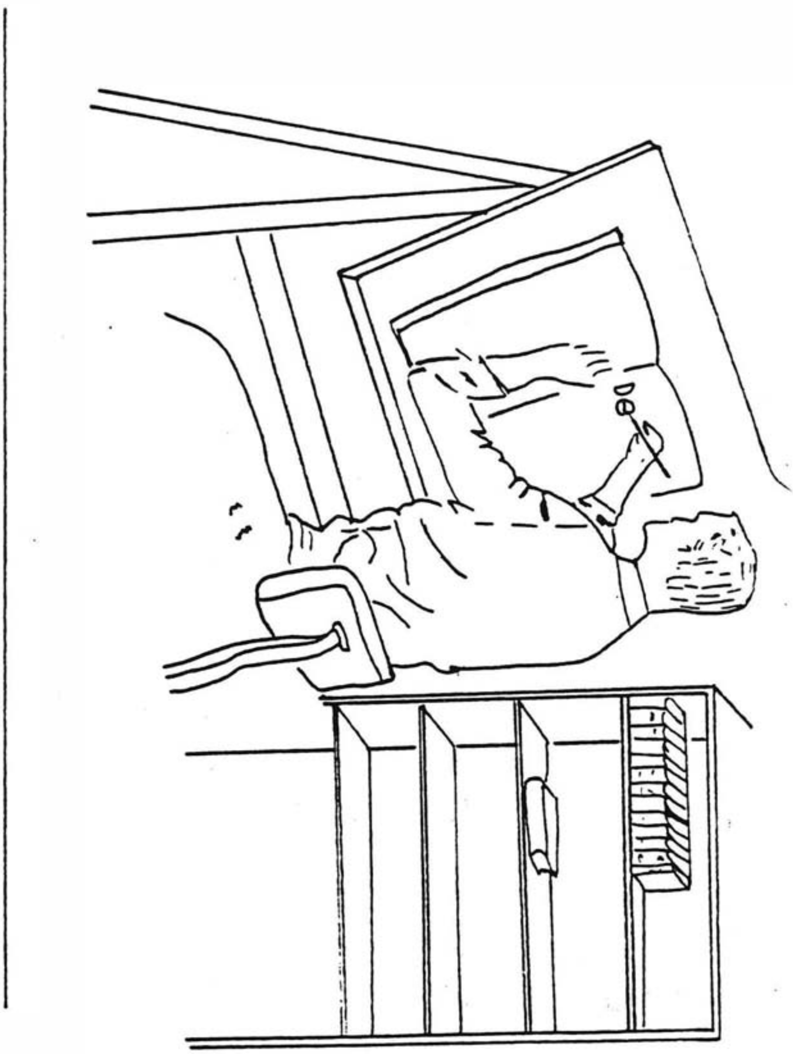
Peak Sound Levels of Items to the Nearest Whole Number

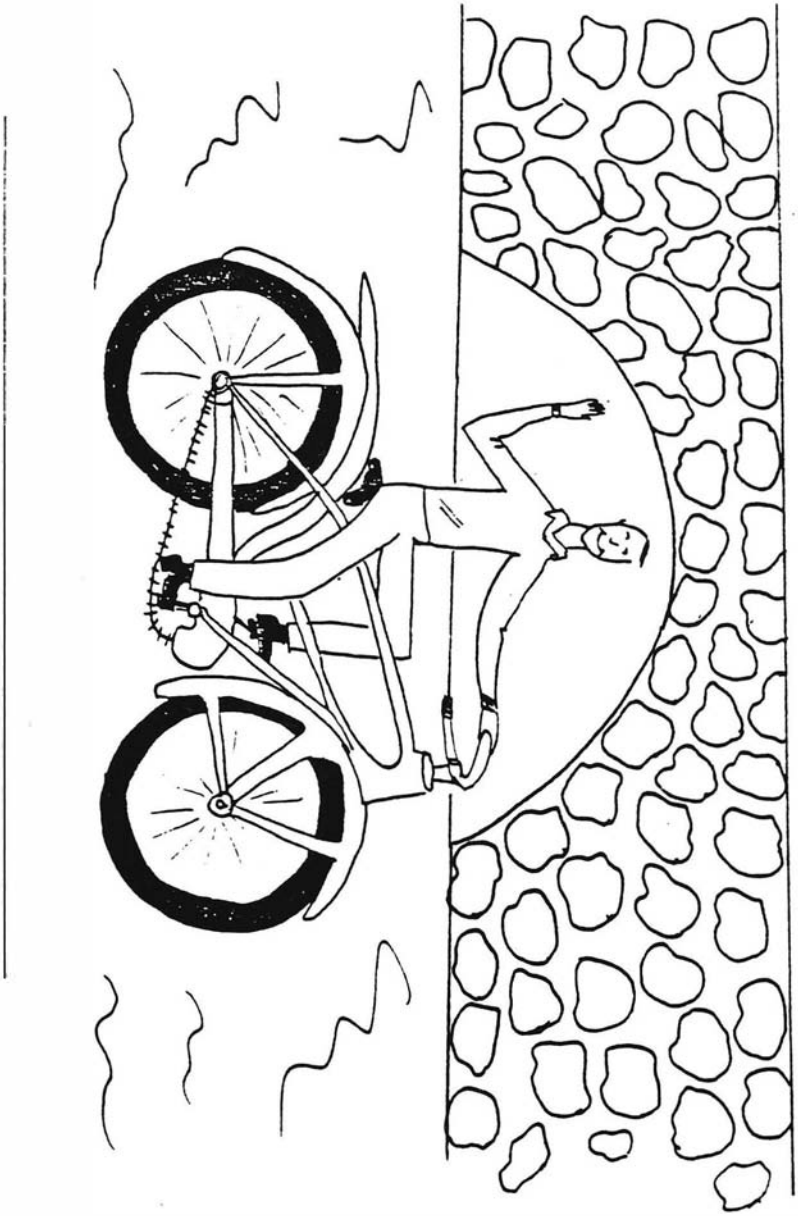
Baseline dB SPL (i.e., simply with tape player on but not running tape): ARD: 47, ANRD: 49, ENRD: 47, ERD: 46

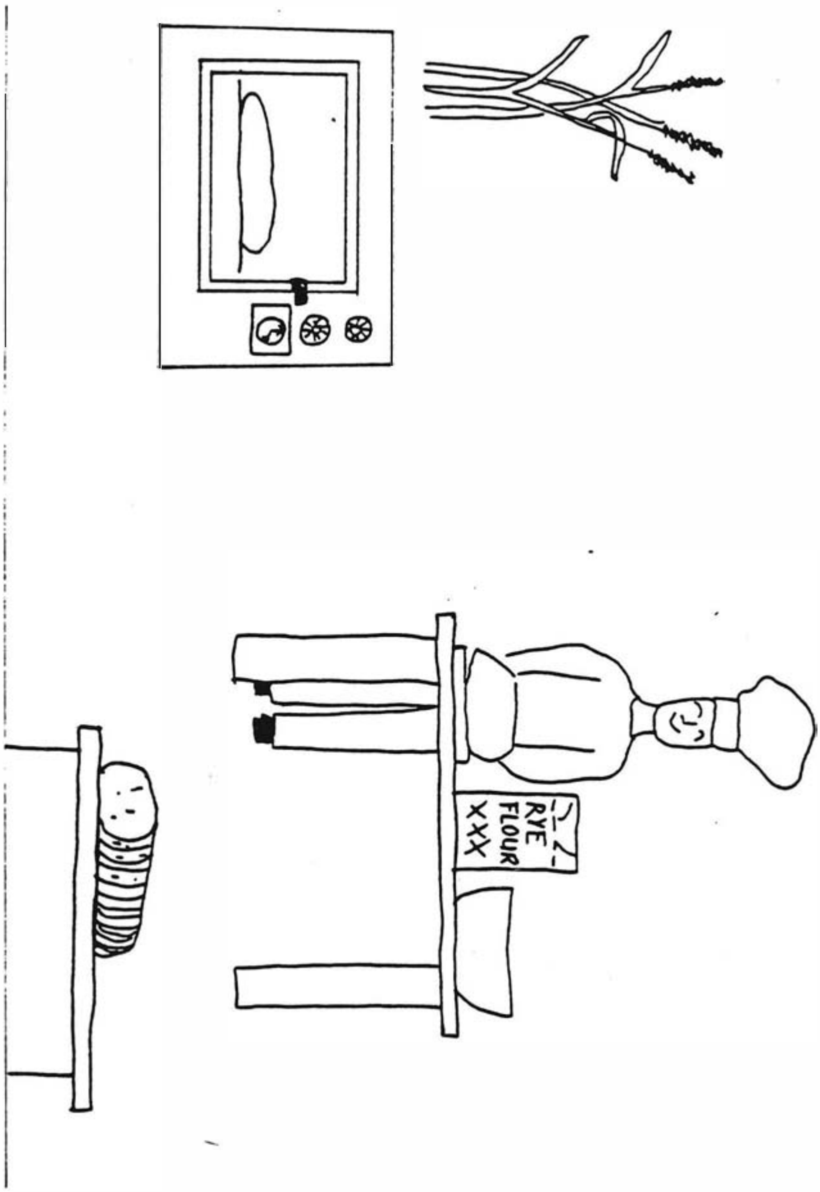
	Item	Mean Peak db SPL			
		ARD	ANRD	ENRD	ERD
1.	people	81	82	81	79
2.	banks	79	80	79	77
3.	sweet tart	81	82	81	80
4.	market	84	86	84	83
5.	gasoline	81	82	81	80
6.	writer	83	84	83	81
7.	a name	85	86	85	85
8.	both thought	82	84	82	84
9.	cracks in the glass	91	92	91	89
10.	market	84	86	84	83
11.	bad weather	81	81	81	80
12.	sweet tart	85	85	85	83
13.	may cry	85	86	85	86
14.	both ought	82	84	82	84
15.	rider	92	93	92	89
16.	a name	85	86	85	83
17.	gasoline	83	86	83	81
18.	make rye	84	85	84	83
19.	mark it	85	86	85	86
20.	daisies	86	86	86	85
21.	an aim	84	86	84	83
22.	both ought	80	83	80	80
23.	match	78	81	78	77
24.	writer	86	88	86	87
25.	sweetheart	84	85	84	83
26.	may cry	86	90	86	86
27.	an aim	85	86	85	82
28.	mark it	81	82	81	81
29.	both thought	84	86	84	83
30.	rider	86	84	86	85
31.	sweetheart	81	84	81	79
32.	make rye	84	86	84	83
33.	people	80	82	80	80
34.	prisoners	82	85	82	82
35.	banks	82	85	82	82
36.	drink	84	81	84	83

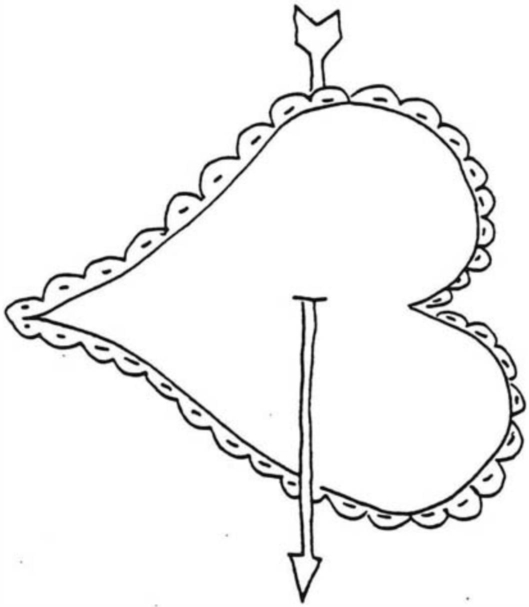
Appendix 8

List of Line Drawings

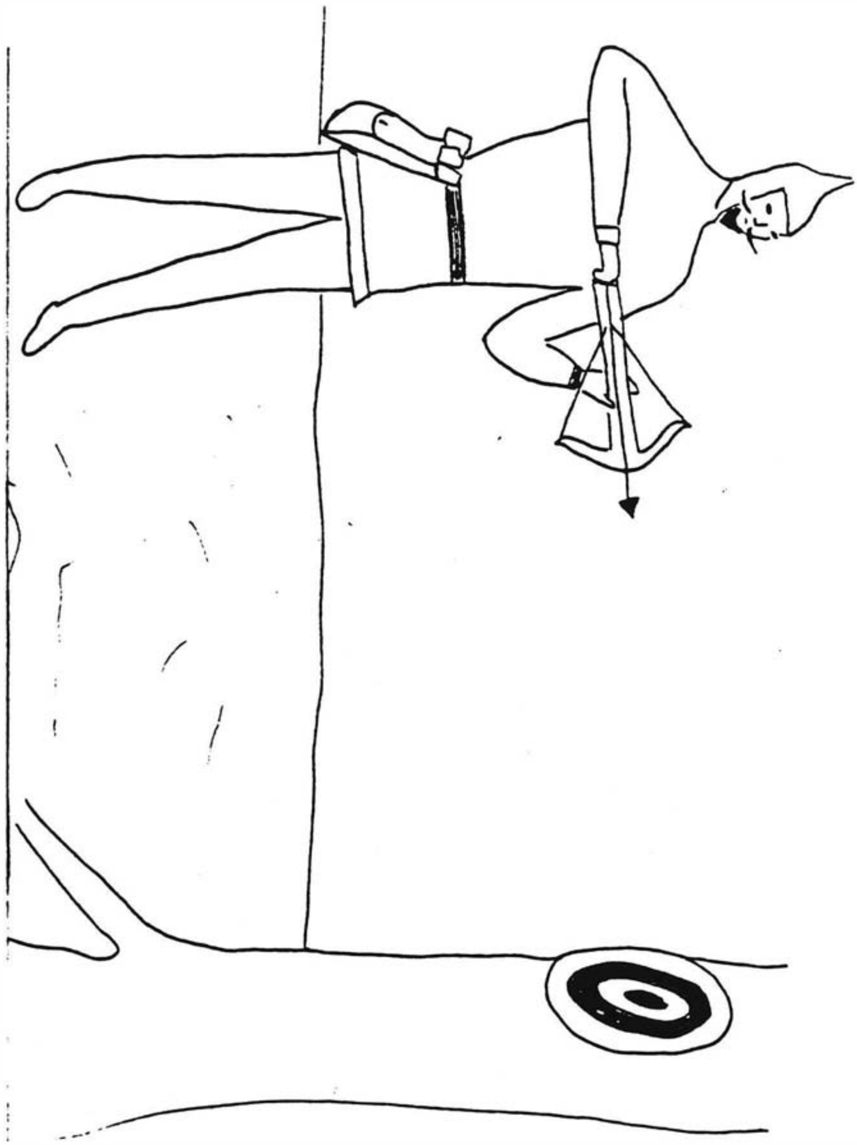


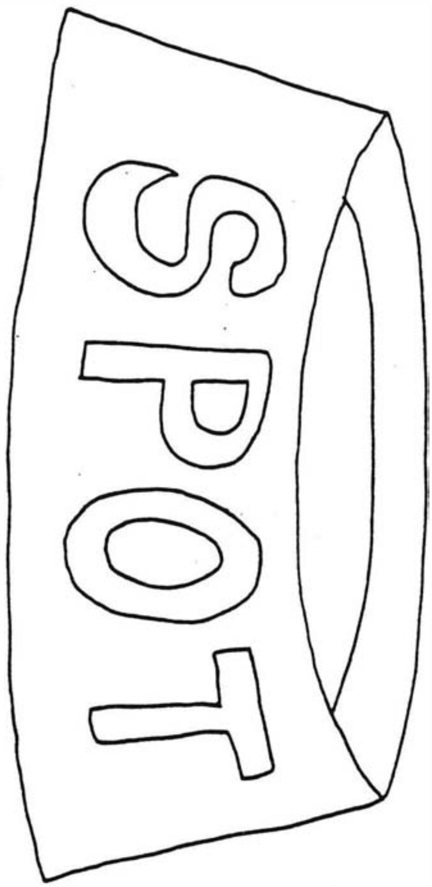



RYE
FLOUR
XXX




SweeTARTS
ASSORTED FLAVORS
TANGY CANDY

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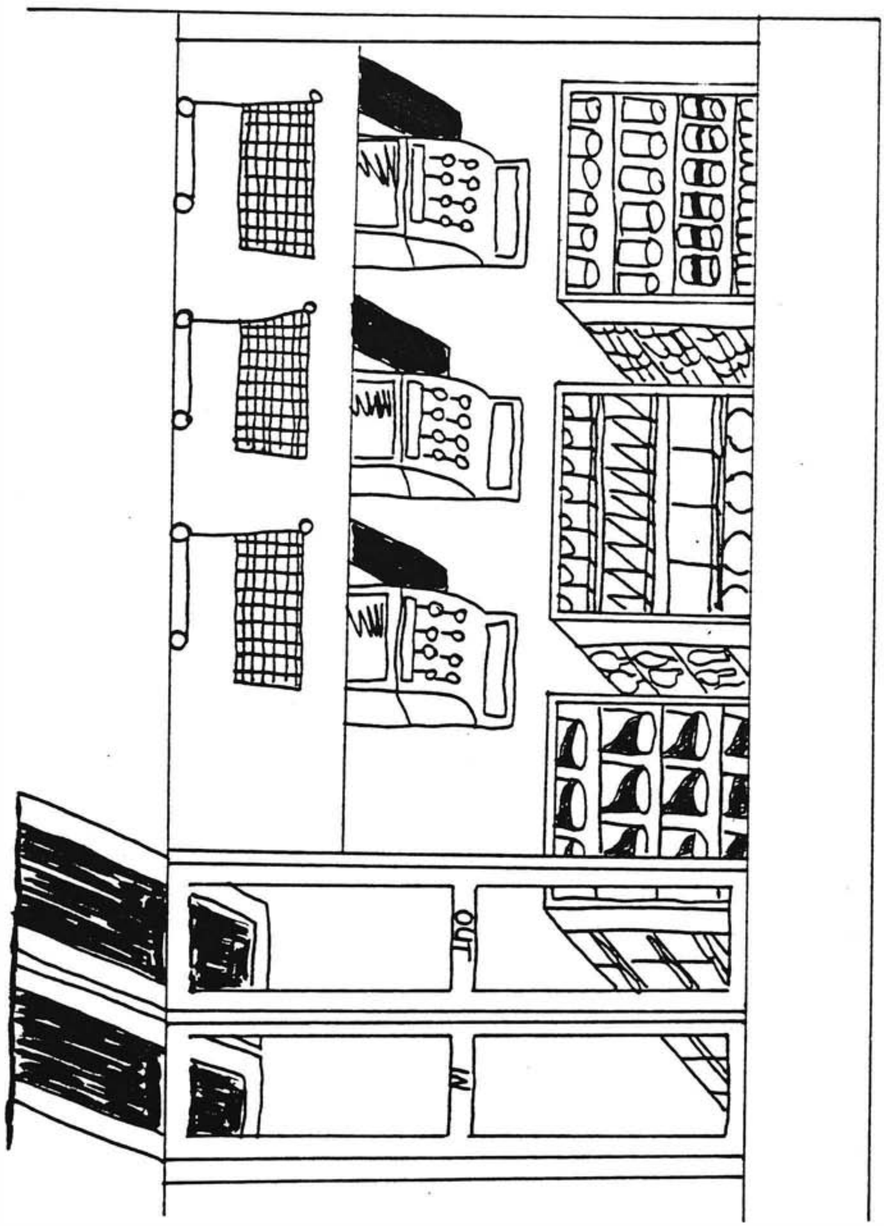
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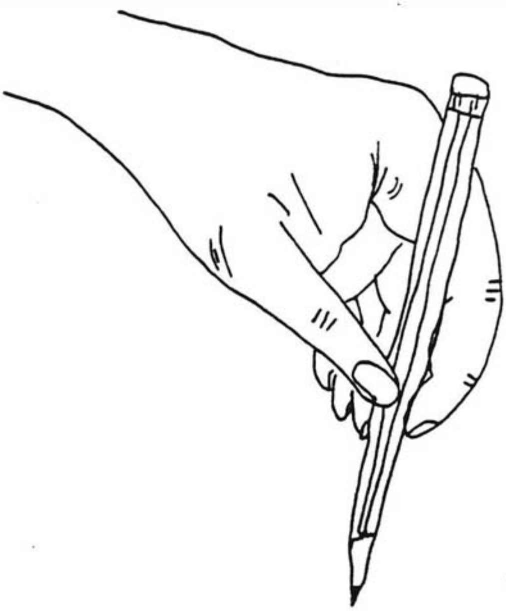
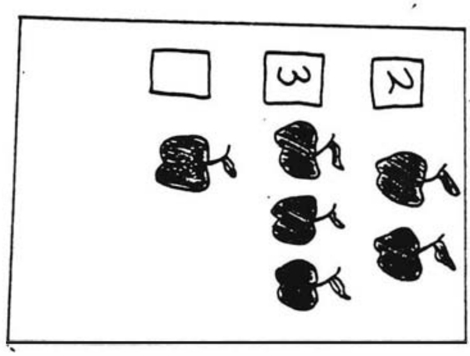
IN

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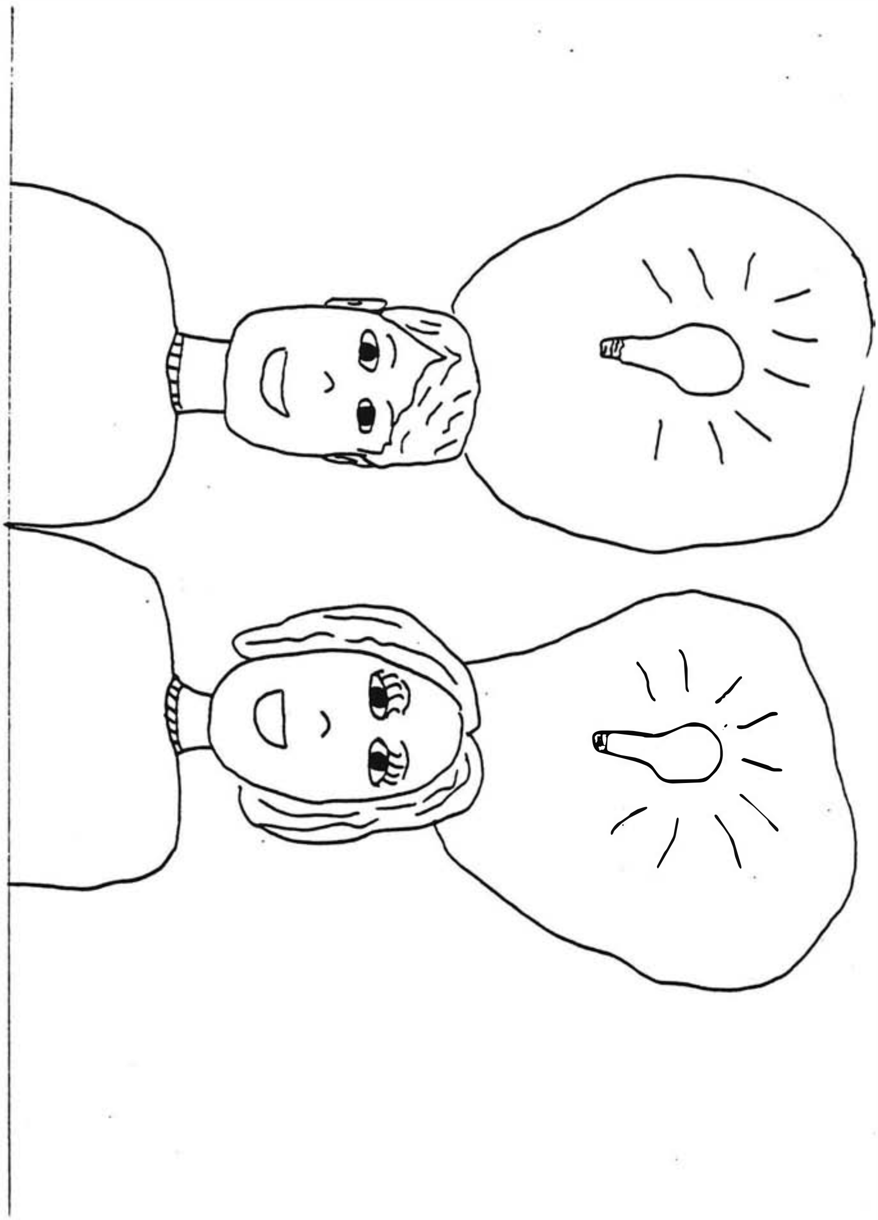
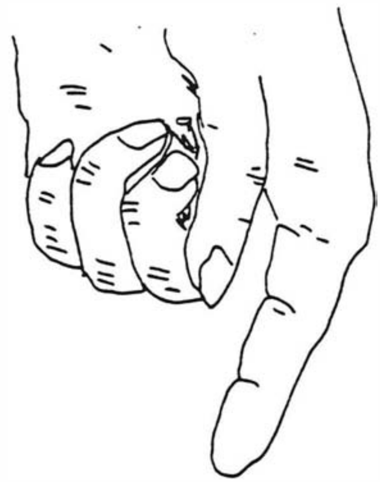
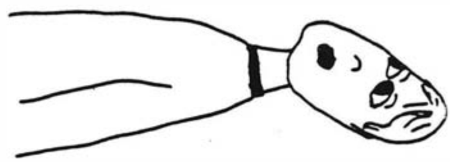
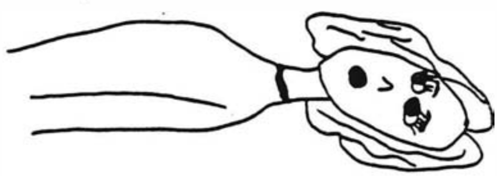
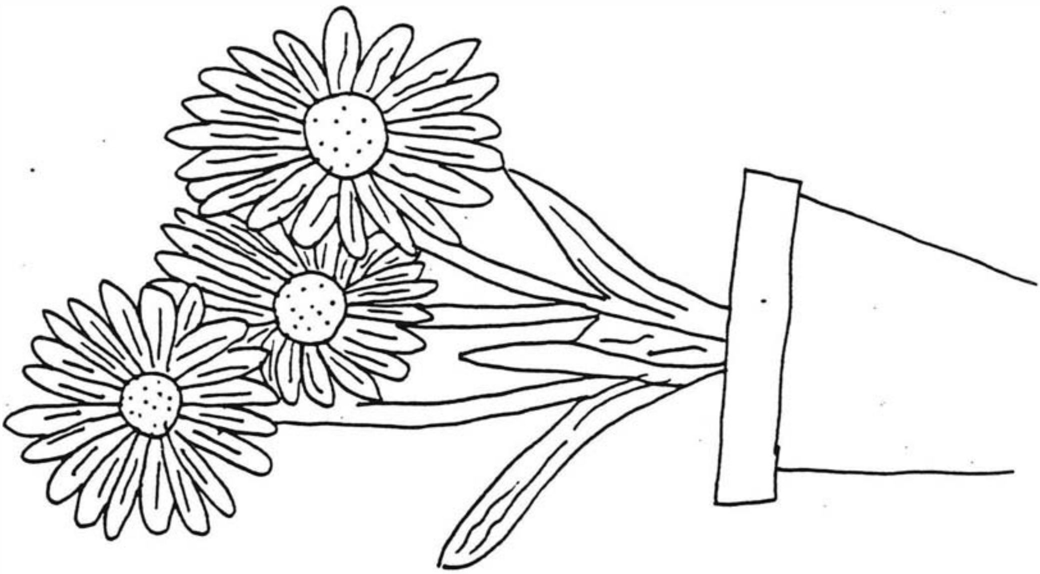
2

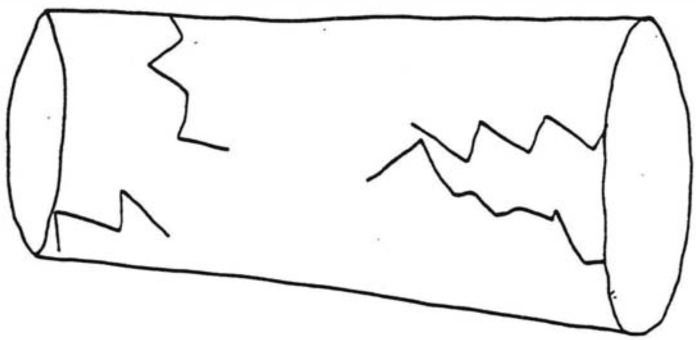


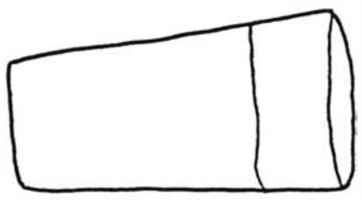


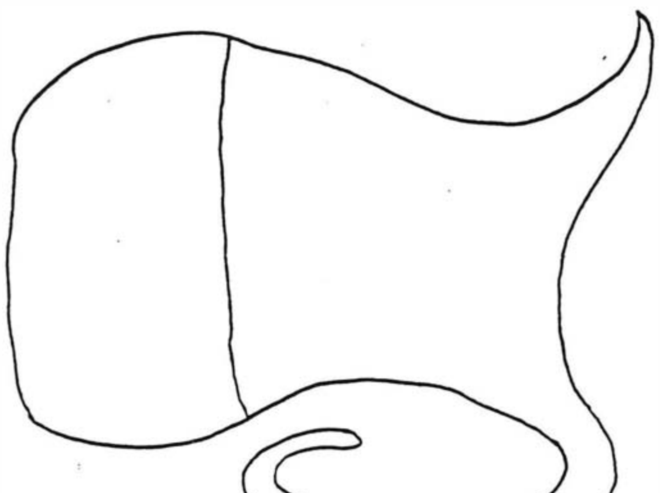


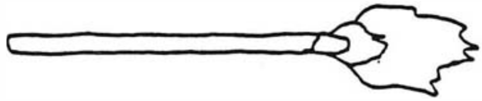


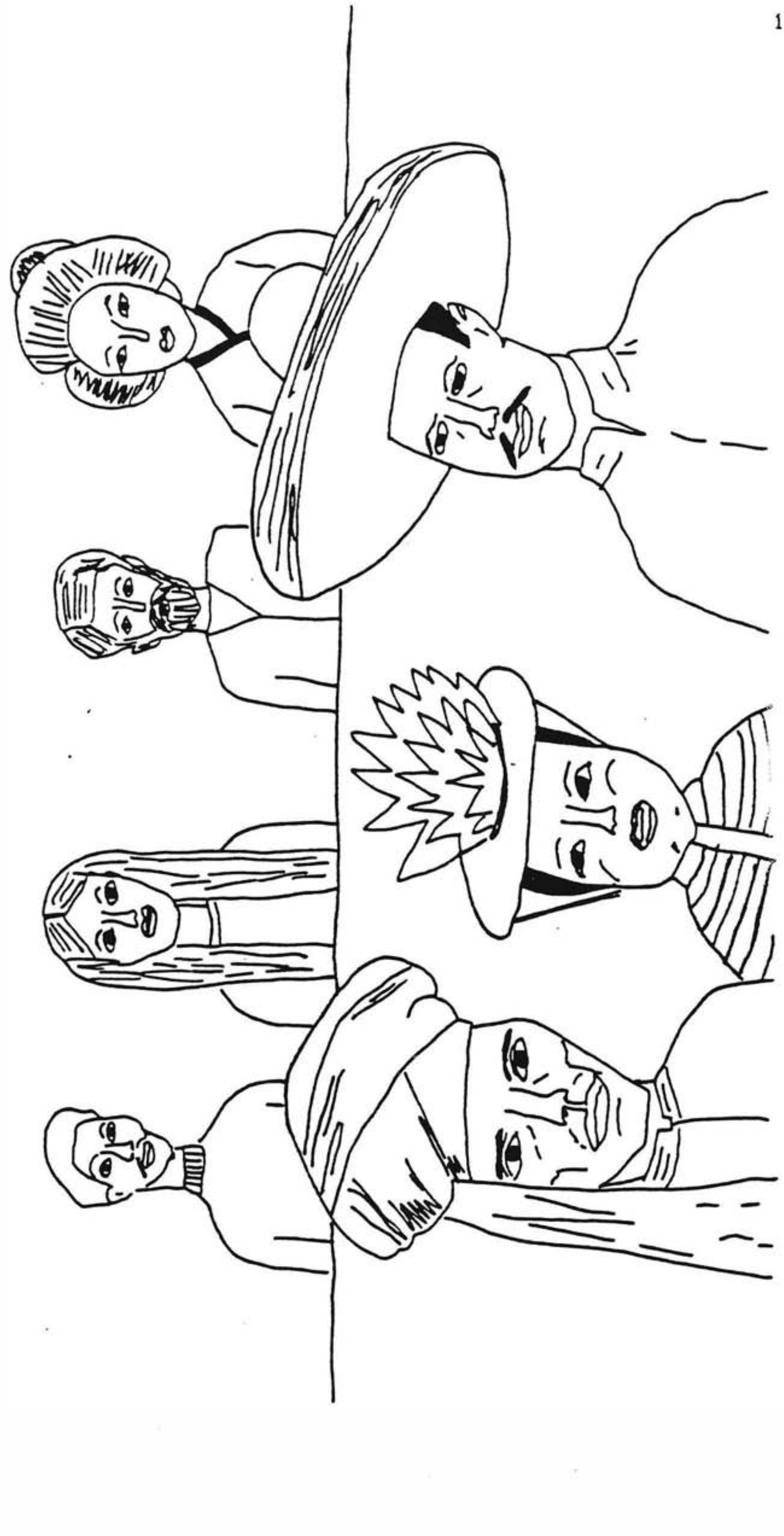


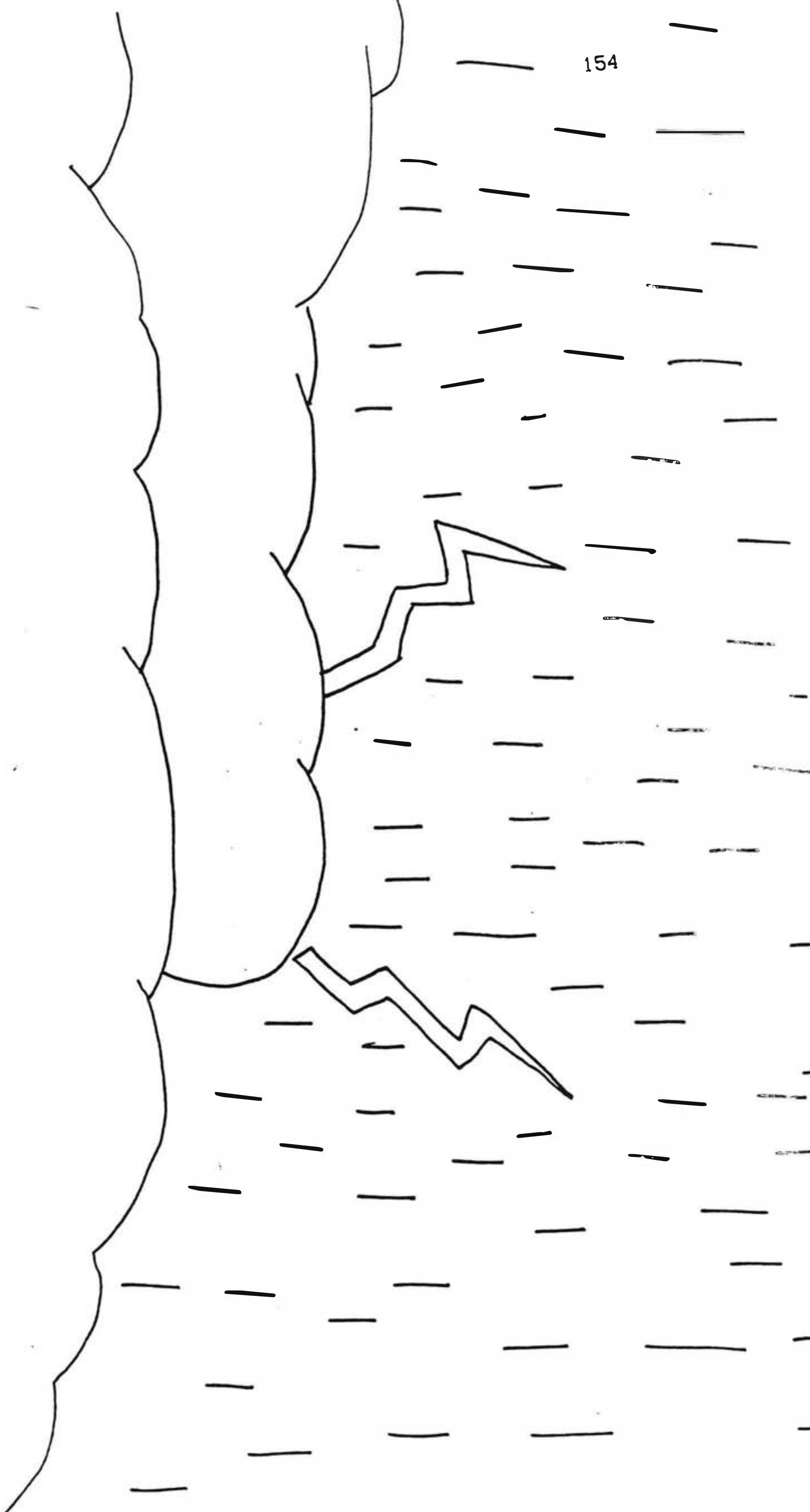


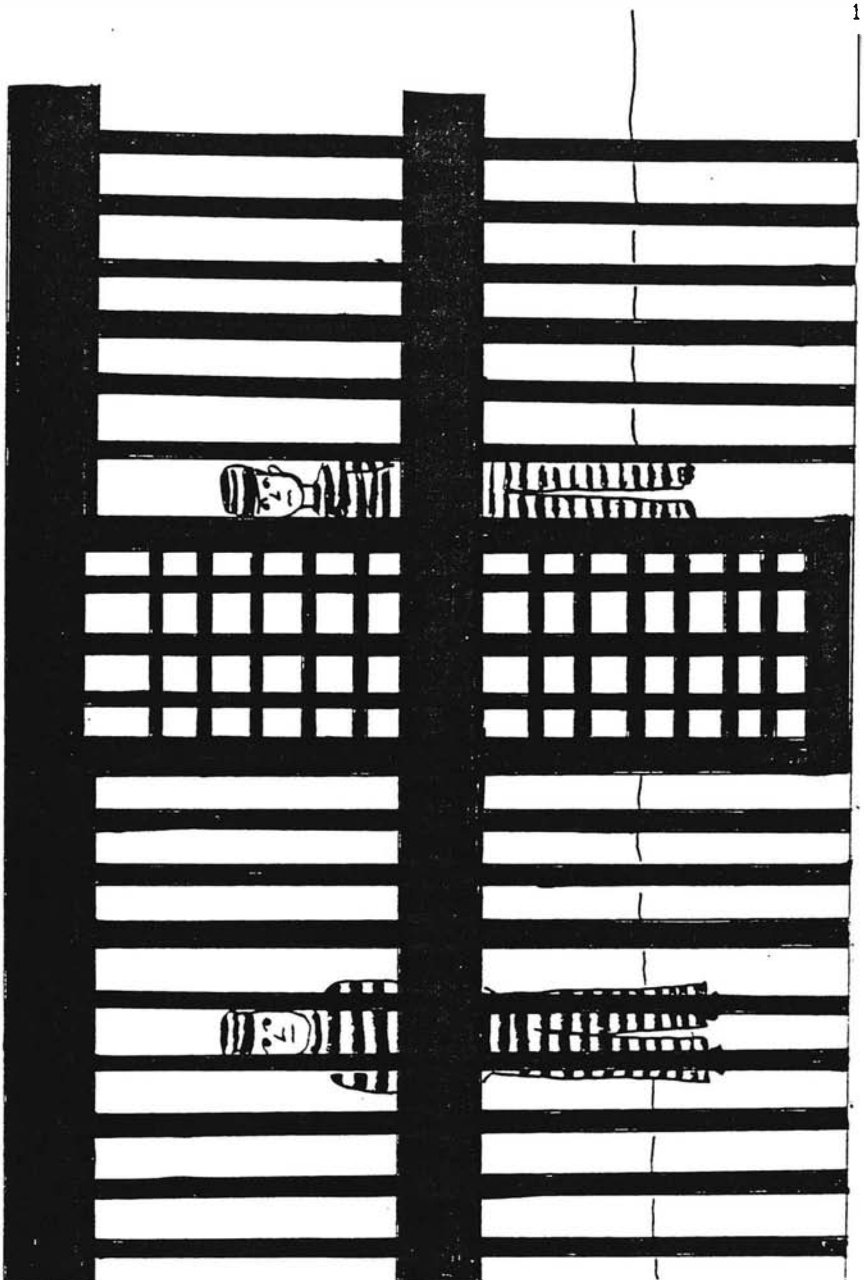


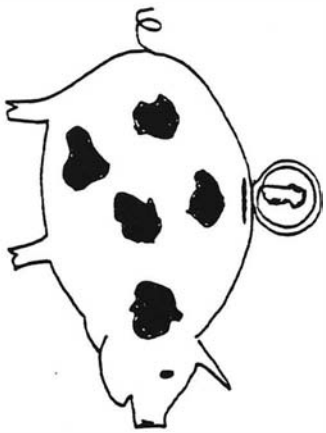


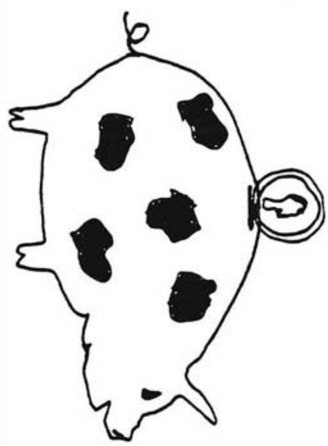


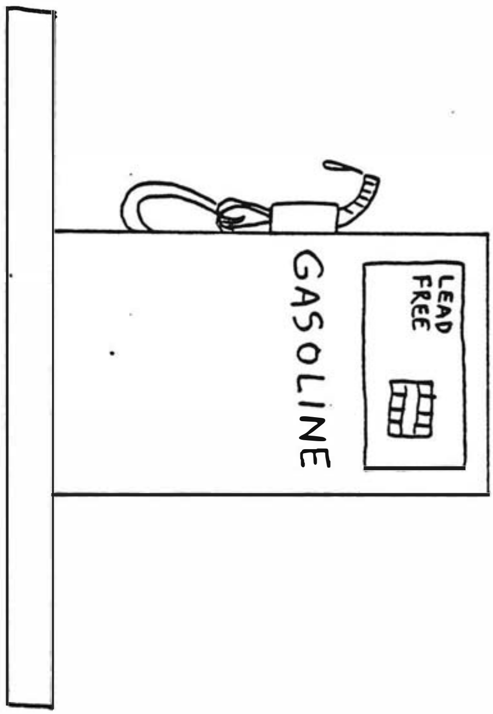




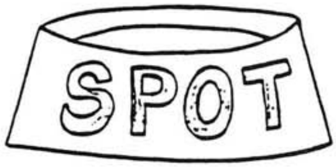







GASOLINE
LEAD FREE

Sample Picture Sheet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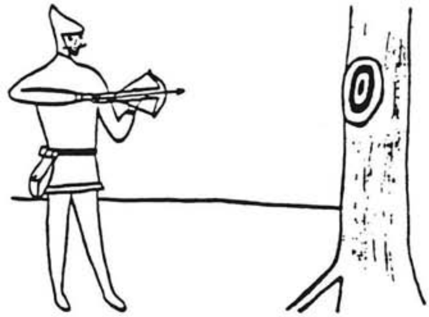
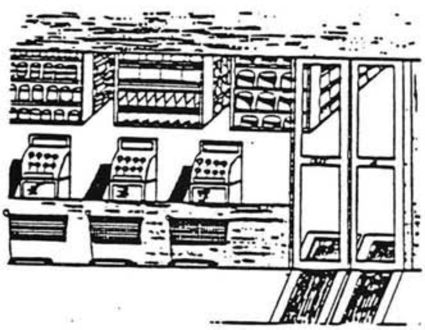
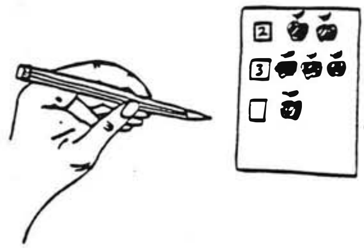
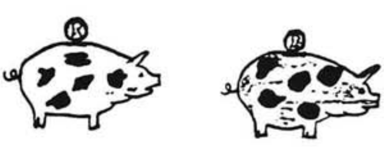





2
3



Appendix 9

Order and Location of Picture Presentations

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

26. may cry

market	mark it
may cry	make rye
banks	match

27. an aim

cracks in the glass	bad weather
mark it	market
an aim	a name

28. mark it

banks	drink
writer	rider
may cry	make rye

29. both thought

market	drink
people	cracks in the glass
both thought	both ought

30. rider

bad weather	gasoline
writer	rider
may cry	make rye

31. sweetheart

writer	rider
people	bad weather
sweet tart	sweetheart

32. make rye

market	mark it
make rye	may cry
gasoline	prisoners

33. people

make rye	may cry
people	match
writer	rider

34. prisoners

sweet tart	sweetheart
rider	writer
people	prisoners

35. banks

rider	writer
market	mark it
banks	match

36. drink

mark it	market
an aim	a name
drink	gasoline

Appendix 10

Phonetic Ambiguity Response Sheet

Item	Subject's Repetition	Meaning	Picture	Rater's Judgment
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				
21. an aim				
22. both ought				
23. match				

Item	Subject's Repetition	Meaning	Picture	Rater's Judgment
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				

Vita

[redacted]