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A comparison of the phonetic accuracy of spelling errors of normal and retarded readers, second through sixth grade.

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A COMPARISON OF THE PHONETIC ACCURACY OF SPELLING ERRORS OF NORMAL AND RETARDED READERS-SECOND THROUGH SIXTH GRADE

by

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ABSTRACT

The present study examined the relative percent of phonetically accurate spelling errors achieved by 19 retarded and 24 normal readers on the Wide Range Achievement Test Spelling subtest which was administered to all subjects in second, fourth, fifth and sixth grades as part of a larger battery of tests. An analysis of variance was carried out for this 2-way, fixed effects, one repeated measure design. It was hypothesized that (a) retarded readers would have significantly fewer phonetically accurate spelling errors and (b) both groups taken together would show a significant increase in their percentage of phonetically accurate spelling errors from study 1 (year 1) to study 4 (year 4). Subjects were matched for IQ and Group membership was determined using dual criteria based on the Metropolitan Achievement Test Reading and Word Knowledge subtests. Misspellings for every subject on each of the WRAT spelling subtest words were collated and rated independently by 2 raters using a procedure developed for this study. This procedure makes use of the 'Table of Common English Spellings' from the _Random House Dictionary_. Raters used the table to decide whether a given grapheme in a child's misspelled word could reasonably be considered to be a good 'map' to the sound (Phoneme) which occurs in

the correct pronounciation of the word. An agreement between raters of 89% was achieved using this procedure. The results confirmed the first hypothesis regarding a difference between normal and retarded readers, but not the second hypothesis, which predicted a longitudinal effect. In addition, the results demonstrated a highly significant interaction effect. The existence of this interaction effect was interpreted as evidence that retarded readers do in fact lag behind normal readers in the development of those skills necessary for phonetic spelling. However, it was also demonstrated that retarded readers do not fully catch up to the normal readers and in fact the means for the two groups appeared to level off after study 2 (approximately age 9½). This last finding was interpreted to mean that retarded readers exhibit a defecit in one or several of those subskills necessary for phonetic spelling. A third hypothesis predicting high correlations between the dependent variable, phonetic accuracy percent, and 4 measures of reading and spelling achievement was partially confirmed. In the first two studies 5 out of the 8 achievement measures were significantly correlated for subjects in the retarded reader group, while only 3 significant correlations were found for this same group in studies 3 and 4. Just the opposite was found for the subjects in the normal reader group. For them, there was only 1 significant correlation in studies 1 and 2, while 5 were found in studies 3 and 4.

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TABLE OF CONTENTS

TABLE OF CONTENTS CONTINUED

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

After a century of reading and spelling research the most telling statement that can be made is that, as yet, we do not understand these processes very well (Fries, 1962). Gibson (1972) points out that many studies have not been careful in defining the particular level of reading being studied, whether it be reading words, sentences, or paragraphs, reading for full meaning or skimming, or reading for information or for pleasure. Furthermore, there is no generally accepted comprehensive theory of reading, so that much of the research is poorly coordinated, with results that are difficult to compare. The most robust (i.e., supported by a wide range of research methodologies) and consistent findings would appear to be those relating the auditory-acoustic, and articulatory processes to reading and to spelling. This is true of both studies of normal reading acquisition and of specific dyslexia (commonly defined as "a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence, and socio-cultural opportunity,...(and) dependent upon fundamental cognitive disabilities which are frequently of constitutional origin." [Critchley, 1970, p. 276]).

It seems clear that the same skills, (referred to hereafter as phonetic analytic-synthetic skills) which are involved in the production and perception of verbal sound sequences, also provide the basis for the initial learning of reading and writing skills.

The word 'initial' is emphasized in the last sentence because there is a handful of longitudinal studies (Satz, Friel & Rudegeair, 1974; Rourke & Orr, 1974) which have shown that the configuration of skills, underlying reading, changes as the child grows older. This research has been carried out with the purpose of identifying potential predictive measures of future reading ability. They have also attempted to answer the question of whether reading disability seems to be related to a basic neuropsychological deficit in, or a maturational lag in development of, key component subskills necessary for reading and spelling (Rourke, 1975).

The intent of this study is (1) the establishment of the rating procedure for determining phonetic accuracy of spelling errors, as a reliable instrument both across time and rater, and (2) the investigation of the relationship between phonetic accuracy of spelling errors and reading ability over a four year period (second to sixth grades). While there are a few longitudinal studies of phonetic analytic skills (Calfee, Lindamood & Lindamood, 1973), no work has been done using childrens' spelling errors to measure these skills. It is only recently, (Boder, 1971) that the phonetic accuracy of spelling errors has been utilized in cross-sectional studies of retarded readers.

Through this study it is hoped that the following questions will be answered: (1) Do normal and retarded readers, as groups, differ in the phonetic accuracy of their spelling errors? (2) Does the phonetic accuracy of spelling errors of these two groups change over the four year period and if so do the groups move closer together, farther apart, or maintain their distance? (3) Is there a correlation between individual reading ability and the phonetic accuracy of their spelling errors? and (4) What is the predictive accuracy of first year level of phonetic accuracy for reading and spelling achievement in the fourth year of the study?

It is hoped that this study will help to clarify the role of phonetic analytic-synthetic skills in the acquisition and development of reading and spelling skills. It is further hoped that this study will serve as a first step in establishing the rating procedure, which is quick, easily learned, and readily applicable in a school setting, as a valid measure of underlying phonetic analytic skills. Clearly, further studies will be needed to determine what specific phonetic skills are being measured by the rating instrument, e.g., auditory, verbal short term memory, sound segmentation, sound blending, cross model matching, etc..

To understand the importance of auditory-phonetic skills in learning reading and spelling, let us consider the effectiveness of reading skill in the deaf, who have had no experience of aural speech. Furth (1966), using as a criterion, normal fourth grade reading level, found that only 12% of a midadolescent group of deaf children were able to read. Deaf students seem to reach a plateau at the fourth grade level and do not improve beyond this with additional schooling. However, it is important to note that some deaf people do learn to read, and the implication, clearly, is that phonological coding, for those of us who do hear, is most likely a strong preference, but not a necessity.

The strength of this preference was demonstrated by Murray (1967). Several earlier experiments (Conrad, 1962; Murray, 1966) showed that, when visual items were presented to subjects for immediate or delayed recall, they were encoded in phonological form. Murray presented subjects with a series of phonologically similar words, reasoning that this would render the phonological coding process inefficient and lead to a switch to some other form of coding, most likely visual. He found, however, that subjects persisted in their use of the phonological code despite impairment to their ability to recall.

While cross cultural studies, comparing the difficulty of learning English to learning other languages, have not been carried out, largely because the methodological problems are so overwhelming, one interesting study, carried out in Finland (Venesky, 1973), can be cited. Finnish is said to have one of the worlds most regular languages, in that its orthography consistently maps to the spoken language system. Each phoneme always has the same letter irrespective of its place in a word! (Kyostio, 1973). Venesky found that a very high percentage of Finnish children could pronounce most words at the end of first grade, thus demonstrating a very unusual level of letter-sound mastery (if they were to be compared to first graders in Canada). While correlations between letter-sound mastery and reading ability were only moderately high (accounting for 25% of the variance in grades 2 and 3), this finding is explainable by the fact that there is relatively little variance in this population for this ability and therefore we could not expect it to be a very good predictor.

Makita (1968), has found that the incidence of dyslexia in Japan (0.98%) is some ten times lower than that found in Western countries. Furthermore, within Japan, the incidence of dyslexia in users of the highly regular Kana scripts is far less than the incidence for users of the ideographic Kanji scripts. Mikita concludes that "...the specificity of the used language, the very object of reading behavior, is the most potent contributing factor in the formation of reading disability" (p. 613).

Elkonin (1963) provides additional evidence that children learn early to decode languages which closely match sound to writing (in this case Russian). He used a variety of techniques for teaching preschool, non-literate children to discriminate the sound structure of spoken Russian words and found that this training assisted children, when confronted with written words and pseudo words, in reading them aloud with nearly perfect pronunciation. It is worth noting, in addition, that Hildreth (1968) found that 98% of Russian first graders learn to read without difficulty.

The studies reviewed to this point suggest that phonetic coding while clearly, not absolutely essential to learning to read, will be used far more often in learning to read those languages which have relatively high phonemic-graphemic regularity. Furthermore, there is some tentative evidence that the more phonemically regular a language is the more easily the reading process is acquired (Mikita, 1968; Elkonin, 1963).

Regularity of English Orthography

At this point it will be helpful to review the range of opinion and related research bearing on the issue of the regularity and irregularity of English orthography. In doing so, we can begin to get some feel for the way a novice reader makes use of the regularities at different levels in the spoken and written langauge systems in learning to 'map' from the second (written) to the first (spoken) and vice versa. It is, perhaps, not too obvious a point, that, by the age of four or five, before formal reading instruction has begun, a child already has acquired a nearly complete phonological rule system. This will include implicit knowledge of proper intonation (stress), segmentations (pauses), and the distinctive features of phonemes and use of a phonological rule system (Messer, 1967; Morehead, 1971). In addition, he will have command of a semantic system (conceptual structure and lexicon) and a syntactic rule system (morphology and grammar) (Gibson, 1972). The six year old beginning reader is thus faced, not so much with learning a new system, as with learning to 'map' these phonological system skills to a new graphological system of related skills: recognition of the categorical features of writing, segmentation (letters, white spaces), recognition of distinctive features of letters and knowledge of orthographic, semantic, and syntatic rule systems as applied to written English.

Keeping in mind the original question of how regular English orthography really is, it should now be clear that this is another way of asking, "What is the level at which the phonological system becomes mapped to the new developing graphological system?", or, "What is (are) the basic decoding unit(s) in moving from one to the other?" The assumption being made here is that it is the detection (not necessarily conscious) of certain basic underlying regularities which allows the child to use first the spoken language, and later the written language. Read (1971) studied the self taught spelling systems of twenty preschoolers and found that in every case, they were based on an underlying phonetic principal, with the phoneme-letter correspondence most often being based on the letter's name. This clearly supports the idea that spelling (and language behaviours generally) are rule governed behaviours and that acquisition of these skills will at least include making use of what regularities exist in the given language.

There are several theories which propose to explain this 'mapping' from one system to the other. Each favors a particular coding unit, and cites research to support its claim.

The first theory favors mapping at the level of one letter to one phoneme (i.e., a letter is an instruction to utter a particular sound). To the authors knowledge, proponents of this position do not believe that English, as it is used, can be characterized this way, but wish it were so. Typical of this point of view is Bloomfield (1933), who holds that "writing is not a part of the language, but simply an imperfect image of speech....(and that) English orthography is simply a grossly irregular alphabet system." (Pp. 500-501). It was this sentiment that sparked the spelling reform movement of the early twentieth century.

Bishop (1964) investigated the significance of knowledge of component letter-sound relationships in reading new words. She simulated the child's acquisition of reading skills by teaching adults to read some arabic words using 12 arabic characters with perfect letter-sound associations. Two training techniques were compared, one using letters, the other whole words. Her results clearly showed the letter training group were able to learn to read and pronounce the list of new words in the fewest trials. Of interest is the fact that several subjects, trained with the whole word method, had learned all 12 letters-sound correspondences despite no direct training in these. It is possible that these results are in part due to the fact that Arabic, like English is an alphabetic system. The results might well be quite different if subjects had been trained on a logographic system.

A second position has been taken by a group of men (Russell, 1958; Fries, 1967) who advocate that English orthography is reasonably regular at the level of individual phoneme-grapheme matching. Learning to read is likened to an associative learning task. Phonemes are the basic sound units of a language (40-50 in English depending on which linguistic analysis you prefer) by which the morphemes (smallest meaning bearing units) and words are represented. A phoneme is normally identified by determining when an alteration in sound is sufficient to change the meaning of the spoken unit, e.g., in contrasting the sounds of the words 'bit' and 'pit' we are able to identify the two phonemes /b/ and /p/. A grapheme then, is merely the possible letters or groups of letters which can represent each of the identified phonemes.

Several studies have undertaken to study the degree of regularity (defined simply as frequency) with which these correspondences exist in the English orthography (Hanna & Moore, 1953; Horn, 1957; Hanna, Hanna, Hodges

& Rudorf, 1966). The last study by Hanna et al. involved the analysis of 17,310 words using a pronunciation system that included 30 consonant and 22 vowel phonemes. He found that there were a large number of phoneme-grapheme correspondences that were indeed regular (occurred at least 80% of the time in both stressed and unstressed syllables).

Other research has focused more directly on the question of what potential value these correspondences have in facilitating reading (Gibson, Pick, Osser, & Hammond, 1962; Gibson, Osser, & Pick, 1963). They invented two sets of pseudo words, one pronounciable, the other not, based on rules of English phonology. Half of these words began and ended with permissable consonant clusters (e.g., 'blong'), while in the other half, the consonant clusters were transposed, rendering the word unpronounceable (outside the canons of English phoneme sequence rules, e.g., ngobl). These words were presented to subjects tachistoscopically and it was found that the pronounceable words were very consistently read with fewer errors. While this finding seems to support the hypothesis that reading is enhanced by having good correspondence between phonological and orthographic rules, a further study (Gibson, Shurcliff, & Yonas, 1970) using deaf subjects yielded similar results. In as much as the deaf subjects lacked experience of the phonological system, and its regularities, it appears that the orthographic rule system may be able to be learned separately, although the mastery of it will never be as complete as with partial or normal hearing subjects.

The findings of several recent studies (Hayes, 1966; Ruddell, 1968a; Downing, 1965) have further supported the importance of close grapheme-phoneme correspondence in facilitating reading acquisition. Typical of this work is a study by Samuels and Jeffrey (1966) in which pseudo-letters were used to represent English graphemes and were matched on a one to one basis with English phonemes. They found that kindergarten subjects, who were taught to decode words on the pseudo-letter to sound basis, as opposed to using a "whole word" decoding method, were significantly better at transferring their skills to new words. Jeffrey and Samuels (1967) in a later study, replicated these results, but attributed their results to one aspect of the experimental procedure which taught subjects to blend phonemes represented by the pseudo letters. Silberman (1964) also found that transfer of phoneme-grapheme correspondences depended on training in phonic-blending. Ruddell (1968b) notes that these results "suggest that sound blending places the phonemes in a natural sound-unit context constituting a more elaborate decoding unit, which is of value in transferring sound-letter correspondence information to new letter patterns and words" (p. 64). The role of sound blending of phoneme units is further discussed below in connection with the role of articulation in reading and spelling.

In summary, those who argue for the central role of phoneme-grapheme correspondences in learning to read and spell have demonstrated that modern English is not so thoroughly chaotic, so irregular in its phoneme-grapheme correspondences, that the child must abandon all hopes of using spelling cues in learning to read, merely memorizing words by sight. There are consistent relationships between sounds and letter patterns in the English orthography and an efficient reader must develop high speed recognition responses for these comparatively few contrasted sets of spelling patterns.

The Jeffrey and Samuels (1967) and Silberman (1964) studies point out the importance of sound blending in learning to read new words and suggest that the context of a grapheme, its surrounding syllable or word environment, may carry valuable information concerning the phoneme to which it should be mapped. The third theory which proposes to explain mapping from the graphemic to the phonemic system is based on this same point. Venezky (1967, 1970a, 1970b), having recognized that direct phoneme-to-grapheme mapping would not take a child very far, undertook an analysis of the spelling-to-sound regularities in a 20,000 word corpus. This immense study yielded a systematic analysis of the graphemic patterns in English words (the classes of graphemes, th, ch, oo, tch, dg...etc., and the allowable sequences of these letters, and letter combinations) and a description of how these graphemes indirectly map to sound.

Venezky's (1970a) major inference from his analysis is that "spelling units are not related directly to sound, but to an intermediate (morphophonemic) level first, and then to sound" (p. 34). He points out that this indirect approach allows a clear separation of rules based on orthographic considerations from those based on morphological and phonological ones. Orthographic rules illustrated in the first part of his study are used in translating from the graphic symbols to the morphophonemic level, while a second set of phonological rules are applied in mapping from the morphophomenic level to the actual sounds produced. Thus, in order to read the word 'mishap' a person would, according to Venezky, first need to make the judgement that 'sh' does not form a cluster in this word. This decision is reached using orthographic rules (in this case relating to morpheme boundaries) to segment the word as mis/hap. At this point, phonological rules would be applied to yield the correct pronunciation of the word.

Venesky enumerates the following factors which mediate the correspondence between spelling and sound:

1. Morphemic boundaries. The spelling ph regularly corresponds to the phoneme /f/ as in 'sphere', 'phase' and 'morpheme', but clearly does not in 'shepherd.' Rather than cite this as just another idiosyncracy of English orthography, Venesky instead formulates the more parsimonious rule that "ph corresponds to the phoneme /f/ when it lies within a single graphemic allomorph and that across morhpeme boundaries it is treated as separate letters" (p. 90). There is, therefore, a hierarchy of decisions implicit here. First the reader must decide on correct morphemic (also syllable) boundaries, and only then, attempt to match pronunciation to graphemic units.

2. Form class. The pronounciation of any form ending in nger or ngest cannot be predicted unless the morphemic identities of the [er] and [est] are known. If they are the comparative and superlative markers as in stronger, strongest, then the ng sound is /ng/. In some other words the 'ng' is represented by the phonome /ŋ/.

3. Graphemic environment of the unit. The unit c corresponds to the /s/ phoneme when it precedes e, i,

or y plus a consonant (deceive, decisive, icy). In many other positions the c corresponds to /k/.

4. Stress. The 'x' may be pronounced /ks/ or /gz/ depending on the main stress in the word: axioms, exercise vs. examine, exist (other possibilities do exist).

5. Position in the word. The initial 'gh', as in ghost, ghoul, corresponds to /g/, while in the medial and final positions, 'gh' has pronounciations other than /g/.

6. Phonological influences. Certain sound sequences are not allowed in English so that when a sequence of disallowed phonemes is signaled by a spelling, one or another of the sounds drops out. For example /bp/ and /pb/ do not occur as adjacent sounds within word boundaries, so that words like 'subpoena' and 'clapboard' retain the pronunciation of only the second consonant.

Venezky's careful work has obviously greatly clarified the exact nature of the regularities which underlie English orthography and phonology and has given us rules for 'mapping' from one system to the other (orthographic to phonological). However, it is not enough to say that these regularities and mapping rules do exist. As Venesky (1967) himself points out, "the question that remains to be answered is: 'Do the literate actually use this pattern?'" (p. 80).

Phonetic Analytic Skills and Reading

While research based on Venesky's analysis of spelling to pronunciation regularities in English, and particularly aimed at discovering if children use these regularities, has only recently begun (much of it at the Wisconsin Research and Development Center for Cognitive, Learning), the results of several studies are available.

Calfee, Chapman, and Venezky (1970) studied two samples of kindergarten students on their rhyming ability and found that, even with considerable training there was a clearly defined subgroup of children who could not learn to make simple rhymes. It appeared that these children simply did not have the concept of phonetic simularity. A further study with Israeli children (Venezky, Shiloah, & Calfee, 1972) confirmed these results on three different rhyming tasks and also demonstrated a significant correlation between rhyming ability and scores on tests of reading achievement at the end of first grade. They also found a clear developmental trend in rhyming ability across the first two primary grades. Ability to recognize and produce rhymes has been said (Gibson & Levin, 1975) to "indicate ability to deal with sounds as abstractions....(and to be) important for later acquisition of spelling patterns." (p. 229).

Another study (Calfee, 1972) utilized a number of tests developed by the Wisconsin group to investigate possible component skills involved in the reading process. These tests, including visual word matching, phoneme identification, phonetic segmentation, alphabet recognition, and vocabulary recognition, were given to a number of children just beginning first grade, and were later compared with measures of reading achievement. Multiple regression analyses with several samples of children consistently revealed the importance of phonetic segmentation and phoneme identification in developing reading skill. One disappointment was the relatively low predictive value (30% of the variance) these tests had for first grade reading achievement.

These findings were supported by Rosner (1971) who conducted an experiment to see if auditory perceptual skills could be trained. A group of non-readers entering first grade were given special training in auditory analysis and, on a post-test, when compared with a control group, were found to significantly excell in reading both familiar and new words. Training in this case was progressive, beginning with nonverbal sounds, then segmenting in turn, phrases, words, syllables, and finally single phonemes.

These results strongly support the importance of auditory-perceptual analysis of words as an important skill in learning to read. Training does help and shows transfer at least in the early stages of learning to read. We may now ask what role these auditory analytic skills play as children progress through the primary grades, and improve or fail to improve in their reading skills.

In a study using older children, Calfee, Venezky, and Chapman (1969) have shown that American children generalize the invariant consonant and the long- and short-vowel correspondences to sound early in the primary grades, but fail to generalize several other predictable patterns until the end of grade school. Furthermore, analysis of pronunciations of these predictable patterns showed that the percentage of appropriate pronunciations increased from third grade to high school, that better readers in third and sixth grades were consistently more likely than poorer readers to give appropriate responses to predictable patterns, and that certain predictable patterns were not totally mastered by even the better, older readers. These findings would seem to support the theory that the acquisition of reading, taken to be a hierarchy of complex skills, takes place through the sequential learning of simpler and then increasing complex sub-skills. The fact that correlations between reading level and pronunciation were high in third grades

(.66 and .52) and lower in sixth graders (.16 and .46), suggests that, what predicts successful as well as unsuccessful reading, changes from the early to later grades. It must also be realized however that the range of reading ability in the population against which an individual's performance is being compared changes considerably over this same period.

As an additional part of the above study, inappropriate responses were analyzed in terms of their possible appropriateness (given a different word environment for that letter or letter combination). Interestingly, this analysis of what might be termed graphemic inaccurate, and graphemic accurate pronunciation errors of written words, is the exact inverse of the current study which investigates phonemic accuracy of the spelling of words which have been heard. Poor readers were found to give twice as many "wild" (graphemic inaccurate - the letters never have the pronunciation in any word or morpheme environment) pronunciations as good readers. This relationship decreased somewhat by sixth grade and the authors reported that both good and poor readers continued to increase their mastery of predictable letter-sound correspondences through high school.

These last several studies strongly suggest that phonetic analytic abilities, as measured by pronunciation errors, develop progressively through the grade school years. At first, children's pronunciations reflect only the most consistent, regular grapheme to phoneme correspondences, so that word pronunciations dictated by more complex rules, such as morpheme boundaries, graphemic environment, etc., are rendered incorrectly. By the end of grade school many of these conceptually more complex rules for spelling-to-sound correspondence have been mastered. In addition there is some evidence to suggest that retarded readers are often slower to develop these phonetic analytic skills, although for this group as well the relationship between phonetic analytic skills and reading level seems to decline toward the end of grade school.

This consistent finding of a lowered correlation between phonetic analytic ability and reading ability (particularly comprehension) over the primary school year calls for some explanation. One explanation, suggested by Gibson and Levin (1975) is that "as letter-sound generalizations become more readily available, other factors such as context, come in to play and the correlation with comprehension drops" (p. 295).

This explanation is supported by Venezky and Johnson (1972) who found that the initial and final <u>ce</u> (cent and face) were handled differently at both the third and sixth grade levels, but were not differentiated at earlier grade levels. The /k/ pronunciation, was often used for the initial <u>ce</u> but only rarely for the final <u>ce</u>, suggesting that children at these grade levels are already using conditional cues (position in the word) and have moved beyond simple letters to sound generalizations. Also of note is the fact that normal readers seem to make this transition more readily than poor readers, although the transition was eventually made by poor readers as well. The picture which seems to be emerging is one of a hierarchy of phonetic analytic skills starting with relatively straight forward phoneme-grapheme correspondences to application of increasingly higher order conceptual rules for pronunciations within a given word or morpheme context. Both normal and poor readers seem to acquire these skills, but the poor readers appear to do so more slowly, which is to say, this phonomenon is best accounted for under what has been referred to as a "lag theory" (Rourke, 1975).

Levin and Watson (1963) and, more recently, Ackerman (1973) have added further support to the above impression. Their studies have shown that training in word skills which emphasize a one-to-one correspondence for phonemes and graphemes prove to be a hinderance in the later stages of developing reading skills. The Levin and Watson study simulated children's reading acquisition by teaching adults to map artificial graphemes to familiar words. The study by Ackerman was a direct test of the hypothesis using children. She found that when children are initially trained for variable grapheme-phoneme correspondences, they develop a "more general rule" (or a set for diversity), and that this training was more effective for later transfer of learning.

One last area of research relevant to the role of phonetic analysis and synthesis in reading is the group of studies which examines the strategies underlying recognition of various classes of phonetic and non-phonetic words and letter strings. This field of research is quite extensive and only a few representative studies will be cited here.

The Gibson, Osser, and Pick (1963) study has already been described above. Briefly, they compared first- and third-graders on their ability to recognize tachistoscopically presented familiar words, pronounceable nonsense words, and unpronounceable nonsense words, and found that first graders read and spelled out most accurately the stimuli in the same order as above. The third graders read all the 3 letter words about equally, but longer (4- and 5-letter) unpronounceable pseudo words were seldom read accurately.

Rubenstein, Lewis, and Rubenstein (1971) hypothesized a model for adult (mature) reading which includes a "phonetic recoding" stage intermediate between visual input and accessing of an internal lexicon. They suggested that, regardless of whether a word is seen or heard, a search through the internal lexicon is carried out in the phonemic code. To test this hypothesis they presented college students four kinds of material, real words, legal nonsense words (orthographically and phonologically), words illegal in both rule systems, and words illegal in both systems but still considered pronounceable (e.g., fuzg, tapk). Subjects were asked only to identify the words as such and their reaction times were measured. The authors reasoned that longer reaction times for the fourth stimulus group, compared to the third, would confirm their hypothesis in that the nonword status of more pronounceable nonsense stimuli, could be expected, in a phonetic recoding step, to take longer to detect, in spite of the stimuli violating both orthographic and phonological rule systems. This hypothesis was confirmed.

Spoehr and Smith (1975) proposed a model of word recognition which allows for an initial phase of grouping letter strings into higher order units ("parsing process") which are then decomposed, in a second phase, into graphemic units which can be phonetically translated. In an earlier experiment Spoehr and Smith (1973) had identified the syllable as the optimum "parsing unit" for enhancing the accuracy of tachistoscopic perception. In the more recent experiment, they demonstrated that the perceptual accuracy for a string of letters is correlated with the number of recoding steps needed to convert that string into speech. Furthermore, they were able to demonstrate that perceptability differences of letter strings can be predicted on the basis of the number of phonological violations in the string.

This finding of Spoehr and Smith that letter strings are first grouped into larger units before translation to phonetic equivalents recalls the theoretical position of Venezky (1967) cited above. It seems likely that these larger units yield precisely the contextual cues necessary for the use of the higher order, phonological and orthographic, mapping rules identified by Venezky. While Spoehr and Smith consider only the usefulness of these "parsing units" for applications of phonological rules, it seems likely that orthographic rules could be applied here as well. This raises the possibility that letter units are processed through a dual coding system (Marshall & Newcombe, 1973).

Meyer, Schvaneveldt, and Ruddy (1974) investigated this possibility. They, too manipulated graphemic and phonological relations within letter string pairs and asked subjects to identify stimuli as words or non-words. They found that performance, measured by reaction time, was dependent on phonemic encoding. Dual encoding was found to facilitate recognitions, while graphemic encoding (use of graphic simularities only) was clearly inhibitory.

While the three studies cited hardly constitute a thorough review of current word recognition research, they do serve to point up the current viability in the literature of theories which argue for a primarily phonetic basis for processing of written material. The literature is by no means conclusive and contradictory findings can be found (Bower, 1970; Kolers, 1970).

As previously stated, one premise of the current study is that learning to read can, in part, be understood in terms of mapping from an old system (spoken language) to a new one (written language). It seems only fitting, therefore, that this review include at least a brief description of the research on subvocalization in reading. More complete reviews of this literature can be found in Conrad (1972) and McGuigan (1970).

The following statement by Huey (1908) still accurately characterizes the position of most researchers working in this area today:

> The fact of inner speech forming a part of silent reading has not been disputed, so far as I know, by anyone who has experimentally investigated the process of reading....Although there is an occasional reader in whom the inner speech is not noticeable, and although it is a foreshortened and incomplete form of speech in most of us, yet it is perfectly certain that the inner hearing or pronunciation, or both, of what is read, is a constituent part of reading by far of most people as they ordinarily and actually read. (p. 119-128).

Typically, research evidence for subvocal articulation today is provided by electromyographic (EMG) recordings of the various muscles involved in speech production. The assumption has always been that the silent articulation shown by the EMG record does in fact refer to the material being read, and is not an irrelevant accompaniment. This assumption was recently tested by Locke and Fehr (1970), who required subjects to silently read two classes of words: those that did, and those that did not include labial phonemes (/p/, /b/, /m/, /f/, /u/). Using surface electrodes, they recorded electrical activity in the labial muscles during this task. The results, while not entirely clear, seemed to demonstrate that words with labial phonemes, silently read, use more movement of the labial muscles than do non-labial words. Another comprehensive study of articulation during silent reading (Edfeldt, 1960) demonstrated that silently read text that was difficult, either syntactically or through unfamiliarity or through poor legibility, showed increased articulation. Finally, one author (Conrad, 1972) has summed up the evidence provided by EMG studies this way: "We have to say that articulation almost always occurs, that it is probably task relevant, but that sound evidence that it is necessary is lacking. Other inputs may be equally useful, and possibly concurrent" (p. 210). Keeping this caution in mind, it would still seem a strong possibility that, in reading, we not only say things to ourselves, but that we listen and auditorily process them. In taking up next the research on phonemic coding in spelling, the subvocalization research will provide a convenient bridge from the reading literature.

Phonemic Analytic-Synthetic Skill in Spelling

Much of the theory and research cited thus far has dealt primarily with the role of auditory phonetic analytic processes and their possible role in decoding graphic stimuli. What about the reverse process of decoding auditory verbal stimuli and recoding them to a graphic display (spelling)? What might we expect concerning the role of auditory-phonetic skills in this process?

In a recent review of the research in this area, Groff (1968) defined phonetic abilities as being able to "(a) discriminate aurally the sounds (phonemes) of American English, (b) pronounce these sounds, (c) discriminate visually which letters or graphemes are usually used to represent them in English, and (d) reproduce these sounds in writing after listening to them" (p. 132). He concluded unequivocally that the research shows phonetic skills as listed above to be related to spelling. Children who achieve in the top 25% of their class in spelling have significantly greater phonetic abilities than those who achieve in the bottom 25%. (Russell, 1955; Chase, 1958). Other studies have found reasonably good correlations between knowledge of phonetics and spelling ability (Russell, 1958; Aaron, 1959).

There is still, however, a question of what the relationship is between the phonetic skills implicated in the reading and those underlying spelling. Luria (1966) states that "the analysis of the phonetic composition of speech, the starting point of any form of writing (spelling), naturally requires adequate preservation of phonetic hearing. However, investigations on the early stages of writing skill have shown that articulation plays an essential role in the task of precise definition of the phonetic composition of words." (p. 409). Luria goes on to cite a study of the writing of individuals with disturbances of articulation (Levina, cited in Luria, 1966) which showed that disturbances such as these may severely impair the differentiation of phonemes.

The importance of subvocalization in spelling is further substantiated by Bannatyne and Wichiarojote's (1969) study. They studied third grade children using a battery of tests which included standard spelling achievements tests as well as tests of a variety of auditory and motor functions. They found very high correlations between spelling ab i lity and motor, kinesthetic and praxic processes. Sound blending was significantly correlated with spelling ability and the authors offered the conclusion: "It would seem that the synthesis which is involved in blending sounds during the reading process in some way assists in the reverse situation, namely the analysis of a unit word in inner speech into its component parts which are then encoded (spelled) either vocally or in handwriting" (p. 12). This is an interesting confirmation of a study by Sommners (1961) who found that training in articulation improved reading ability in children. Thus, one way of characterizing the relationship between reading and spelling is that each facilitates the other through common use of phonetic analytic and synthetic abilities. The sounding-out process used by beginning readers in dealing with difficult or unfamiliar text is the same process that young spellers use when they are spelling a new or difficult word. To some extent this reliance on phonetic skills continues even into adult life.

Another study investigating the relationship between spelling and reading was carried out by Peters (1967) who looked at the influence of different methods of reading instruction on the spelling ability and spelling quality of elementary school children. She found that spelling attainment was not differentially affected by look-say, phonic, or Initial Teaching Alphabet (ITA) methods, but that the quality of the spelling errors did reflect these methods. Particularly, she found that children taught using a phonics method made the fewest transpositions, the fewest substitutions of vowels, and produced significantly more phonetically accurate spelling errors. Sweeney (1976) differentiated two groups of learning disabled children, one high in phonetically accurate (PA) spelling errors, the other high in phonetically inacccurate (PI) spelling errors, and found that the PA group was significantly better in oral reading ability ($p < .0001$).

In a factorial study of spelling, Newton (1961) found that several auditory abilities appear to underlie the ability to spell. Spelling of phonetic syllables (.60), phonetic analysis (.63), accurate pronunciation (.51), auditory discrimination of syllables (.36), and auditory memory (.35) were all significantly correlated with spelling ability. This study, which was carried out with 498

6th grade students, suggests that phonetic skills continue to play an important role in spelling achievement of children at least into the late primary grades.

The question of how much a role phonetic skills play in the spelling behaviour of adult spellers has not clearly been established in the literature. It would seem likely that, as with reading, the configuration of subskills underlying spelling would change between the early stages of learning to spell and the end of primary school. C. Chomsky (1970) points out the necessity for children to change from a simple notion of phoneme-grapheme matching to one which recognizes the higher order morphemic determinants of a word's spelling. A child must learn that the spelling of the root segment in a word (which contains underlying lexical information) is often spelled exactly the same (thus, it is argued, facilitating recognition of the common meaning between such words) despite different pronounciations. Some examples of this phonomenon are the words, pronounce - pronounciation, courage - courageous, relative - relation. Phoneme-grapheme regularity is sacrificed in these examples so that the spelling of the central meaning-bearing morpheme can be held constant. Presumably, younger children using rules of phoneme-grapheme correspondence would spell these graphemes differently based on their different sounds, while older children, having learned the rule for keeping constant morpheme spellings across related words, would spell these words correctly.

Frost (1973) studied the spelling errors of children in grades 2, 4, 6, and 9 and classified them over five linguistic areas: phonological influences, graphemic level, submorphic, morphemic, and word level miscues. He found that the errors of children in the ninth and twelfth grades were significantly different from those of the younger children, especially in terms of knowledge of word structure. By the twelfth grade, subtleties such as vowel allophones had been learned, while second graders rendered more unrecognizeable words, and made more substitutions.

Longitudinal studies of acoustic phonetic skills are still rare in the literature. One study (Calfee, Lindamood & Lindamood, 1973) investigating the relationship of these skills to reading and spelling ability (as measured by the Wide Range Achievement Test) from kindergarten to twelfth grade found high correlations between acoustic phonetic skills and both reading and spelling achievement over this entire range. The acoustic phonetic skills required in this study were the ability to arrange colored blocks to represent sound sequences. This study demonstrates that phonetic-analytic skills, despite the more recent acquisition of higher order skills (e.g., for making use of morphemic regularities in related words, etc.) continue to be an important component in the reading and spelling processes.

The question of how the development of phonetic skills procedes is of some importance in that some researchers have recently undertaken to study subgroups of retarded readers differentiated on the basis of their phonetic abilities as evaluated in their spelling errors (Boder, 1971, 1973; Sweeney, 1976). The assumption on their part would appear to be that each group can be characterized as having an underlying defecit which the other group, and normal readers do not. It seems at least as plausible to assume that the underlying phonetic skills in each of these groups are on a continuum, and that the phonetically accurate misspellers merely lag behind on this developmental continuum, with phonetically inaccurate misspellers further behind, and normal readers and spellers further ahead. Phonetically accurate misspellers demonstrate an ability to correctly analyze the phonetic content of a spoken word, fail to match the proper grapheme to the sound, but do use a legal grapheme equivalent for that sound. Phonetically inaccurate misspellers would appear to fail at one of the earlier steps in the spelling process. If it is correct to assert that these two groups of spelling errors are evidence of a maturational lag in phonetic analytic abilities (as opposed to asserting that they reflect a basic deficit), then we should expect to see an increase in the percent of PA spelling errors in the reading retardate group over the primary school years. Note that this does not mean that second and third grade readers will necessarily become normal readers, but that the poor reading of a retarded reader group in the upper primary school grades will be more closely related to other abilities such as the ability to abstract and apply higher order rules for mapping from written to the spoken language system and vice versa. At least some of these older retarded readers may have a very good grasp of the phoneme-grapheme regularities in English, and be able to segment correctly words into their component sounds. Where they tend to go wrong is in applying the morphemic, syntactical, and grammatical rules of English. Their spellings, while phonetically correct, are technically wrong on the basis of these higher order rules. The substrate of phonetic abilities underlying spelling should be expected to undergo a similar developmental change and this should be reflected in a change in the percentage of phonetic accurate and inaccurate spelling errors both groups make.

Summary of the Introduction and Statement of Hypotheses

The theoretical literature and supporting research bearing on the relationship between phonetic analytic-synthetic skills and reading and spelling ability has been reviewed above. While, even now, there is considerable diversity of opinion concerning the role of these phonetic-analytic skills in the reading and spelling processes, there is, nevertheless, virtually unanimity of opinion regarding the importance, of these skills in at least the initial stages of learning to read and write phonetically based languages.

In the preceeding discussion the author described some of the regularities in English orthography and looked at a number of levels on which a person might 'map' from the skills involved in speaking and hearing to those of reading and writing. Research on the relationship between reading and spelling skills are reviewed. The author concluded that reading and spelling share a number of major component skills, not the least of which are those that have been referred to as phonetic analytic-synthetic skills. It is argued, therefore that the phonetic accuracy of spelling errors is one measure of those same phonetic analytic skills used in the reading process.

Finally, the limited literature bearing on the longitudinal development of phonetic skills was cited. This, in part, pointed toward the conclusion that the phonetic analytic skills so important in assisting the child in the early stages of learning to read reach a peak in the early primary grades and tend to grow less important as the child develops fast reflex reading skills probably based increasingly on visual whole word recognition skills.

Based on the previous research or implications of previous research, the following hypotheses were formulated:

(1) Means for the dependent variable, the percent of phonetically accurate misspelled syllables, will be significantly different for normal and retarded readers. (There will be a significant group effect.)

(2) Means for the dependent variable will be significantly different across the four studies. (There will be a significant longitudinal or study effect.)

(3) Level of reading and spelling achievement will correlate at a significant level with degree of phonetic accuracy in misspelling. In the last 3 years of the study these correlations will tend to decrease.

CHAPTER 11

METHOD

All of the data for this study was drawn from a 4 year longitudinal research project dealing with reading and spelling performance of normal and retarded readers (Rourke & Orr, in press). The procedures for selection and classification of subjects are described below. Following that, there is a description of the analysis to which the data was subjected for the purposes of this study.

Subjects

There were 24 subjects in the normal reading (NR) group and 19 subjects in the retarded reading (RR) group. The subjects were first- and second-grade male students attending one of several urban schools in Windsor, Ontario. The schools were chosen because of their geographical proximity and their relatively homogeneous socio-economic makeup (lower middle to middle class). The subjects in each group were screened for visual and auditory acuity deficits as well as emotional disturbances. English was the primary language for all children. At the time of the first examination, the groups were matched for age. For the NR group, the age range was 88 to 100 months, and the average age was 92.4 months. For the RR group' the range was 87 to 100 months and the average age was 92.4 months. The groups were tested on four occasions (Studies 1 - 4) beginning in second grade and continuing in grades 4, 5, and 6.

Normal readers were selected on the basis of the following criteria: a centile score of 50 or above on the Reading subtest of the Metropolitan Achievement Test (MAT), and a score of 60 or above on either the Word Knowledge or Word Discrimination subtests of the MAT. Subjects in the RR group all had a centile score of 20 or below on the reading subtest of the MAT and 35 or below on either the Word Knowledge or Word Discrimination subtests. The Full Scale IQ range on the Wechsler Intelligence Scale for children (WISC; Wechsler, 1949) for the NR group was 91-117; for the RR group it was 91-114. An attempt was made to include only those subjects who fell close to the normal range of Full Scale IQ on the WISC.

Reading, Spelling and Psychometric Intelligence Measures

For the first examination, the Primary 11 Battery, Form A, of the MAT was used. At that time, the Word Discrimination, Word Knowledge, and Reading subtests were administered. For Studies 2 and 3 the Elementary Battery, Form A, with the same three subtests as year 1, was used. In Study 4 the testers used Form B, Intermediate Battery (partial), of the MAT, which includes the Word

Knowledge and Reading subtests, but not the Word Discrimination subtest. The Reading and Spelling (level 1) subtests of the Wide Range Achievement Test (WRAT; Jastak & Jastak, 1965) were administered on all four occasions to each subject.

Selection Procedure

At the time of initial testing, a number of males in each school were given the MAT, and those who met the criteria were administered the WISC. Where possible (considering the roughly normal range WISC Full Scale IQ requirement and age pairings), normal readers were selected who were as near to the fiftieth centile score on the MAT reading subtest as possible. The WRAT and WISC were administered individually by one of four experienced psychometrists on each of the four occasions over the four year period of this study. These tests were administered as part of a more extensive battery of neuropsyhcological tests. Psychometrists were unaware of the MAT scores of any subject and each tested approximately the same number of subjects in the NR and RR groups.

Spelling Analysis

This study, thus, began with the following data having already been collected: MAT reading score (the criterion for RR and NR group membership), WRAT reading and spelling standard and centile scores for each of the four years, and a sample of at least ten spelling errors for each subject, for each year, drawn from the WRAT spelling subtest.

As the procedure for rating the phonetic accuracy of misspellings used in this study has never, to the author's knowledge, been used before, it is described here in some detail and an example of its use is also cited for clarification.

The rating procedure entailed several steps. Each rater was given a separate page for each of the 45 words on the WRAT spelling test, containing, (1) the correctly spelled word, (2) the word's conventional syllable breakdown, (3) its conventional pronounciation guide with syllable structure matched to (2), and (4) a list of all misspellings of that word, randomly serialized so that the age and group membership of the contributing subject remained unknown (Appendix A). _The Random House Dictionary of the English Language: Unabridged Edition_ (1966) was used as a reference source for determining correct syllable structure and pronounciation guide.

It should be pointed out that rules for syllabling, as well as rules for determining the segmentation of pronounciation guide words are both simply conventional, and vary slightly from dictionary to dictionary. More importantly, these two segmentations need not line up with each other, as the rule systems for each have little to do with each other. Nevertheless, in the great majority of words, these two segmentations do line up and, in fact, there was only one word on the WRAT Spelling subtest where this difference occurred. In this case, the syllabling breaks the word into four segments, en thu si asm, while the pronounciation breakdown leads to five segments, 'en thōō ze az em.' In this one case (the interest being in a spelling-to-pronunciation match) it was decided to consider this to be a five-syllable word.

In addition to these lists of misspellings, raters were given a set of guidelines (Appendix B) for rating the phonetic accuracy of each syllable of each misspelled word. The guidelines asked that the rater, using the syllable guide word at the top of each page, divide the misspelled word in such a way as to make as close a fit as possible with the guide word. Raters were then asked to make a judgement as to whether the letter or letter combinations within each syllable of the misspelled word were allowable graphic representations of the individual sounds of the syllable as represented in the pronounciation guide word. If any one sound (phoneme) was considered to be misrepresented by a letter or letter combination, then the entire syllable was scored as phonetically inaccurate.

The score for a given word was the ratio of phonetically accurate syllables to total syllables in that word.

To assist in making these judgements, a rater was also given a copy of the 'Table of Common English Spellings' (Appendix C) from The Random House Dictionary of the English Language. This table is designed for finding the correct spelling of a word when only its pronounciation is known and consists of a listing of most of the allowable letters and letter combinations which can represent the 45 phonemes identified in the above cited dictionary. Raters therefore, were able, using in combination the pronounciation guide word at the top of each page and the 'Table of Common English Spellings', to arrive at a rapid determination of the phonetic accuracy of most of the misspelled syllables.

The following is an example of how this process was carried out. The rater received a page with the correctly spelled word (prej u dice) and pronounciation guide word (prej ə dis) already broken into syllables. The word to be rated was 'predg u diss'. Having first divided the word into matching syllables, the rater then immediately rated the middle syllable as phonetically accurate (it is correctly spelled). He then turned his atttention to the first syllable where his concern was whether the dg letter combination could represent the /j/ phoneme (sound). Reference to the 'Table of Common English Spellings' readily confirmed this and the first syllable was rated as phonetically accurate. Similiarily with the last syllable, the rater found, using the table, that the ss letter combination was an acceptable representation of the /s/ phoneme and so arrived at a 3/3 rating for this misspelled word.

It must be added that there is still considerable room for disagreement in the correct rating of syllables using this procedure, and that, with some words, the raters had to use their own knowledge of phoneme-grapheme correspondences, and at times, override their initial decision based on the 'Table of Common English Spellings'.

The difficulties which arose, were largely the results of the fact that the table does not, except for giving some example words, take into account the remaining word environment of the letters. It is a well known principle of linguistics that the pronounciation of a given letter (particularly vowels) or letter combination will vary depending on its context within a word or syllable. This is more a problem for vowels than for consonants, and is virtually always a difficulty in representing the schwa, a centralized unstressed vowel. This sound is commonly heard as the a in alone, the e in system, the i in easily, the o in gallop and the u in prejudice. In every case the schwa sound is determined by the surrounding letter environment and the surrounding sound environment (stress and intonation). It is therefore very difficult to judge whether it has been rendered in a phonetically accurate manner in any given syllable, in that, depending on the specific word environment, any one of the five vowels might correctly represent this sound. Furthermore, it is well known that many spelling errors of adult mature spellers are the result of misrendering the schwa sound. To quote Fries (1962):

> "For the writer to use any such words as these (with unstressed syllables) presents a difficult problem. He must learn the particular vowel letter required by each word in order to produce it....There are hundreds of words with this vowel (ə) in the unstressed syllables. The writer must learn...the particular sequence of letters used to spell the unstressed syllables of each individual word." (p. 184)

Other evidence for the importance of considering word environment in determining correct spelling can be found in the tendency in English for a vowel to take a more open sound in a closed syllable (the /a/ in the word date) and a more closed sound in an open syllable (the /a/ in day).

Consonants also show a change in their sound, depending on their position within a word. Therefore, the use of a particular consonant to represent a sound in one position in a word might be judged phonetically accurate (although misspelled), while its use to represent the same sound in another position in that same word would be judged phonetically inaccurate.

One example of how these considerations could have affected a rater's judgement of phonetic accuracy can be seen in the ratings of the two words, nature and reach. Both of these words contain the phoneme /ch/, one in the central position, and the other in the final position. In as much as we are only interested in a phonetically accurate spelling, we might assume that the different letter representations for the /ch/ could be interchanged without affecting the phonetic accuracy of these words. However, it is obvious that while "nacher" is a perfectly good phonetic equivalent, "reatu" is not (despite the fact that tu is an acceptable graphic representation of /ch/ according to the 'Table of Common English Spellings.' The point being made here is that the raters were called on to exercise their own judgement as to the appropriateness of a given phoneme-grapheme equivalence for each particular word environment, and were explicitly instructed to override the 'Table of Common English Spellings' where they thought the grapheme was an inappropriate representation of the sound given that word or syllable environment.

One uncontrolled aspect of the method which may have affected the results of this study should be mentioned.

In the original administration of the WRAT spelling test to the subjects, four different testers were used and no attempt was made to control for the possible subtle differences in their pronounciation of the words. It is therefore possible to argue that some of the judgements of phonetic inaccuracy are incorrect because the child actually heard a word either mispronounced or pronounced differently than is the conventional pronounciation.

Reliability of Phonetic Accuracy Rating Procedure

In the actual rating procedure, two raters, both neuropsychology interns, rated all misspelled words for all 43 subjects. Prior to rating, they were given copies of the guidelines (Appendix B) and the 'Table of Common English Spellings' (Appendix C). They were also given an opportunity to rate a number of sample words. The raters evaluated their respective word lists separately and independently. Inter-rater agreement on the total of 3,082 syllables was 89.8%. There were less than 1% differences in the syllable breakdown of the words. As expected, ratings of the syllables containing a schwa accounted for a large part of the disagreements (44 percent). When these disagreements are subtracted the inter-rater agreement went up to 94.3%.

Following the rating procedure, the two raters, together with the author, rated again all the syllables dis-agreed on in the first procedure, with the expressed intent of reaching agreement on one single score for each word. This procedure was greatly eased by positing a small number of rules (additional to those contained in the guidelines):

(1) Whereever there was a disagreement on a syllable containing a schwa, that syllable was scored as phonetically accurate.

(2) Syllable divisions were to be made rationally. (At times a rater had divided the words in a bizarre fashion so as to give the child maximal credit for the word).

(3) It was permissable to consider a sound as being represented by letter combinations which crossed syllable boundaries. (Several children spelled commission [kə mish ən] with a final syllable, -tion).

(4) The following graphemes were considered acceptable equivalents of the paired letter(s): iy for /ī/; dj for /j/; re for er; and ents for ence.

Following this second group rating session, a total phonetic accuracy percent score was computed for each individual subject using the final agreed upon ratings.

Statistical Analysis

An analysis of variance was carried out in order to assess the significance of differences between the two independent variables, reading ability (RR and NR) and study (year tested), and to investigate the possibility of any interaction effect between these variables. A covariance analysis had been considered because the spelling task for the RR and NR groups differed somewhat in the length and difficulty of the words being attempted. A covariance analysis was not carried out because it was reasoned that the benefit to the normal readers of having more contextual cues available in the longer words was outweighed by the greater difficulty in spelling these longer words (they make greater demands on sequential memory and have a greater number of schwa containing syllables). Also, adjusting for number of words attempted is tantamount to adjusting for spelling achievement level; this is clearly inappropriate.

A correlational analysis was also carried out to determine the degree of relationship between the dependent variable, percent of phonetically accurate syllables, and the percentile scores on the WRAT Reading, MAT Reading, WRAT Spelling, and MAT Word Knowledge subtests within the same study, and in study 4.

A series of stepwise regression procedures was also carried out to determine the relative contribution of the variable, phonetic accuracy percent (compared to the four measures of reading and spelling achievement), to an equation predicting reading and spelling achievement in study 4. These stepwise regression procedures were carried out for study 1, 2, and 3.

CHAPTER 111

RESULTS

Hypothesis 1, which predicted that the retarded reader group would make significantly less phonetically accurate spelling errors, was confirmed: $F(1,34) = 27.59$, $p < .0001$. The cell means and results of the analysis of variance are provided in Tables 1 and 2, respectively. As indicated in Table 2, there was also a highly significant Group X Study interaction effect: $F(3,116) = 11.90$, $p < .0001$. Figure 1 presents a graphic representation of the nature of this interaction. In Study 1 the retarded reader group achieves a much lower percent of phonetically accurate spelling errors than the normal reader group. In Studies 2, 3, and 4, the retarded readers still achieve lower scores on the dependent measure, but the difference between groups has lessened from 36 percentage points to an average of 14 percentage points in these last 3 studies. A simple effects analysis for the 4 levels of study revealed that the between-groups term was significant at the $p < .0001$ level in Study 1 but only at the $p < .01$ level in Studies 2, 3, and 4.

Hypothesis 2, which predicted that the combined groups would demonstrate an increase in their percent of phonetically accurate spelling errors from Study 1 to Study 4, was not confirmed. While the analysis of variance produced a

Table 1

Mean Phonetic Accuracy Percent According to Group, Study, and Study by Group

Study	n	Mean Phonetic Accuracy Percent
	Combined Groups	
1	37	57.8
2	43	78.8
3	43	82.5
4	42	84.0
	Retarded Reader Group	
1	14	34.7
2	19	70.2
3	19	73.8
4	19	78.0
1-4	71	66.2
	Normal Reader Group	
1	28	71.9
2	24	85.6
3	24	89.4
4	23	88.9
1-4	94	84.0

Table 2

Summary of the Analysis of Variance
of Phonetic Accuracy Percent According
to Group and Study

Source of Variation	SS	df	MS	F
Between Subjects				
Group	12781.08	1	12781.09	27.59*
Subjects within Group	15751.94	34	463.29	
Within Subjects				
Study	17876.68	3	5958.89	59.10*
Study X Group	3600.85	3	1200.28	11.90*
Study by Subjects Within Group	11695.43	116	100.82	

*p < .0001

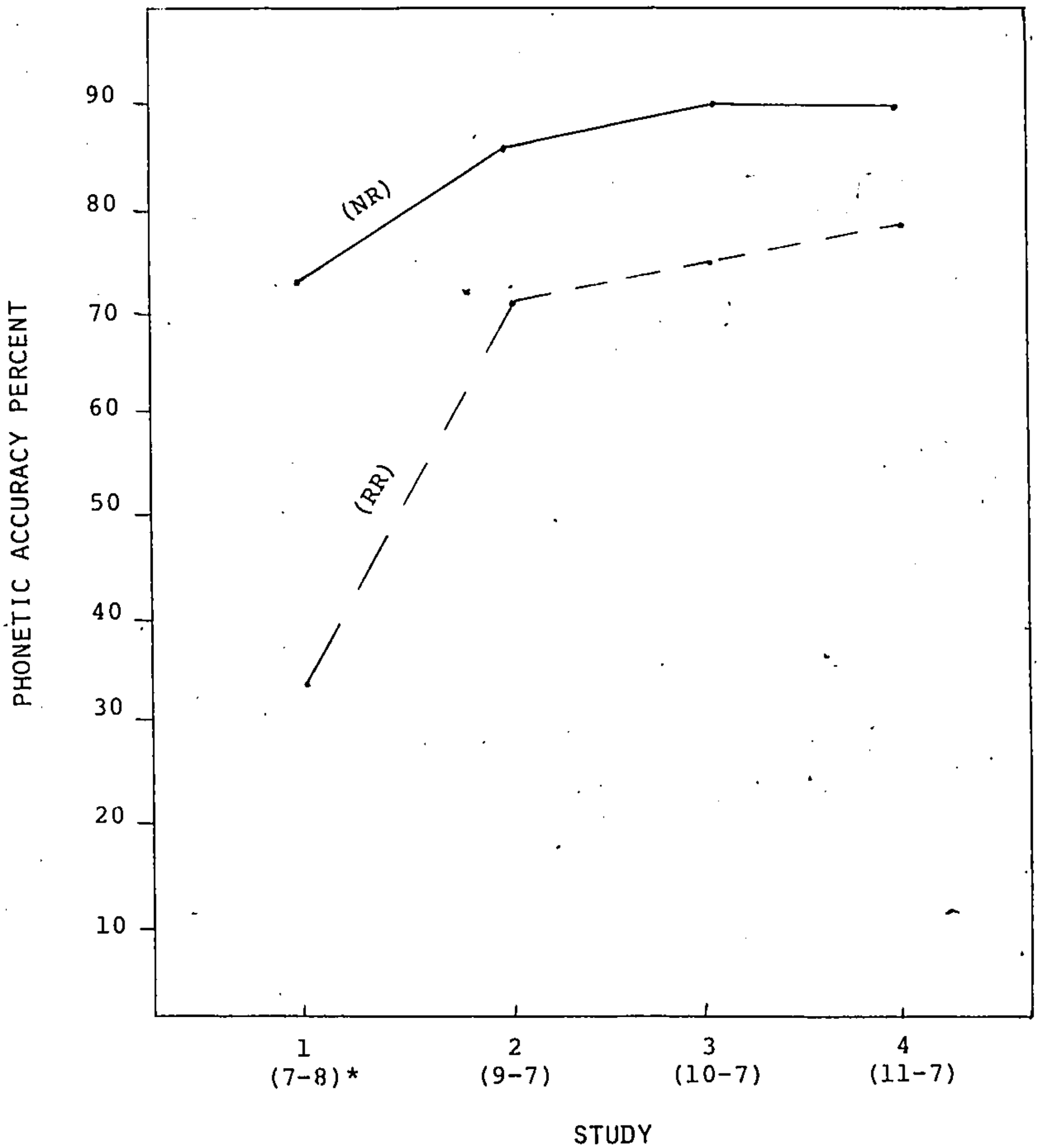

Figure 1. Mean phonetic accuracy percent according to group and study.

*mean age for combined groups

significant F for the study effect: F (3,116) = 59.11, $p < .0001$, it is clear that the within-group term is significant only for the retarded reader group and only for the Study 1 to Study 2 interval. Between Study 2 and Study 4, there is neither an interaction nor a study effect. Thus, in summary, results of the analysis of variance were a highly significant Group and interaction effect. The finding of a significant study (longitudinal) effect was considered misleading in view of the highly significant interaction effect. Specifically, the study effect was almost entirely accounted for by the improvement of the retarded reader group from Study 1 to Study 2.

Hypothesis 3 predicted that the percent of phonetically accurate syllables (PPAS) would be highly correlated with measures of reading and spelling achievement in Study 1 but that these correlations would tend to decrease from Study 1 to Study 4. For the RR group, PPAC is significantly correlated with the Wide Range Achievement Test Reading (WRAT R) and Spelling (WRAT S) subtests and the Metropolitan Achievement Test Word Knowledge subtest (MAT WK) in Study 1 (Table 3). In comparison, in the NR group there are no significant correlations between the four reading and spelling achievement measures and PA% in Study 1. In Study 2 WRAT R and WRAT S are again significantly correlated with PPAS for the RR group, and in

Table 3

Correlation Coefficients for Phonetic Accuracy Percent and Measures of Reading and Spelling Achievement

Group and Study	Measures (Same Study)				Measures (Study 4)			
	WRAT R	WRAT S	MAT R	MAT WK	WRAT R	WRAT S	MAT R	MAT WK
Retarded Reader Group (RR)[a]								
Study 1	.58**	.63**	.03	.59*	.21	.02	.02	.18
Study 2	.49*	.49*	.03	.43	.55*	.42	.48*	.48*
Study 3	.38	.49*	.29	.26	.46*	.37	.47*	.30
Study 4	.48*	.31	.49*	.33				
Normal Reader Group (NR)[b]								
Study 1	.06	.30	-.16	.14	.20	.13	-.20	.09
Study 2	.40*	.38	.32	.30	.40*	.56**	.07	.44*
Study 3	.58**	.52**	.19	.55**	.33	.32	.23	.35
Study 4	.41*	.45*	.09	.25				

[a] $n = 19$.
[b] $n = 24$.
*$p < .05$
**$p < .01$

the NR group WRAT R is now significantly correlated with PPAS. In Study 3, only WRAT S is significantly correlated with PPAS in the RR group and in the NR group WRAT R, WRAT S, and MAT WK are all correlated significantly with the PPAS. Finally, in Study 4, WRAT R and MAT Reading are correlated significantly for the RR group as are WRAT R and WRAT S for the NR group.

In summary, for the RR group, fewer reading and spelling achievement test scores correlated with PPAS in the final two studies than in the first two studies, as predicted, while just the opposite was true for the NR group.

It was also found that the WRAT Reading and Spelling Achievement measures were found to be correlated with PPAS far more often (11 out of 16 correlations were significant at $p < .05$ or better) than were the MAT Reading and Word Knowledge measures (3 out of 16 correlations were significant at the $p < .05$ level or better).

As there was some interest in determining the relative predictive ability of PPAS for reading and spelling achievement levels in Study 4, several stepwise regression analyses were carried out comparing PPAS, WRAT Reading, MAT Reading, WRAT Spelling, and MAT Word Knowledge for their relative contributions to the prediction of WRAT Reading and WRAT Spelling in Study 4. These stepwise regression analyses were carried out between Studies 1 and 4, 2 and 4, and 3 and 4, for separate groups. The results of these analyses are presented in Table 4. The stepwise regression technique attempts to generate the largest R^2 value by adding variables which meet the entry conditions ($F < .5$). As additional variables are added, partial F ratios are calculated for all variables already in the model and those not producing a minimal significant level for staying in are then deleted. The process terminates when no variable meets the condition for entry or when the new variable to be added to the model is the one just deleted from it.

Inspection of Table 4 shows that PPAS shows up in a 'best model' in only one case for normal readers and in none of the models for retarded readers. PPAS and WRAT Spelling in Study 2 produce an R^2 of .65 for the equation predicting WRAT Spelling in Study 4. While there exists a strong possibility that PPAS does not emerge in the regression equation as the second or third variable due to its correlations with the other variables (this point is taken up in the Discussion section), it is nevertheless, important to note that in no case is PPAS the first variable to be selected by the stepwise regression procedure. This is strong evidence that PPAS is, at best, a no better predictor of future reading and spelling achievement than the already existing reading and spelling achievement tests.

Table 4

Best Model (Single or Grouped in Dependent Variables) as Identified by a Stepwise Regression

Analysis for Prediction of Reading and Spelling Achievement in Study 4,

According to Study (1 through 3) and Group

Group and Study	For Predicting Reading Achievement				For Predicting Spelling Achievement			
	R^2	Variable(s)	F Value	Significance Level	R^2	Variable(s)	F Value	Significance Level
Retarded Reader Group (RR)								
Study 1	no variable met .5 criteria for entry into the model				.13	MAT WK	$F(1,16) = 2.36$	$p < .14$
Study 2	.61	WRAT R	$F(1,17) = 27.15$	$p < .0002$	.69	WRAT R	$F(1,16) = 32.24$	$p < .0001$
						MAT R	$F(1,16) = 3.68$	$p < .07$
Study 3	.75	WRAT R	$F(1,16) = 36.19$	$p < .0001$	.78	WRAT R	$F(1,16) = 44.43$	$p < .0001$
		WRAT S	$F(1,16) = 11.36$	$p < .0041$		WRAT S	$F(1,16) = 13.16$	$p < .0025$
Normal Reader Group (NR)								
Study 1	.71	WRAT R	$F(1,20) = 36.46$	$p < .0001$	.40	WRAT R	$F(1,21) = 3.80$	$p < .0016$
		MAT WK	$F(1,20) = 11.71$	$p < .0030$				
Study 2	.34	WRAT R	$F(1,22) = 11.46$	$p < .0029$	.65	WRAT S	$F(1,21) = 33.04$	$p < .0001$
						PPAS	$F(1,21) = 5.46$	$p < .028$
Study 3	.52	WRAT R	$F(1,22) = 24.23$	$p < .0002$	.73	WRAT S	$F(1,21) = 54.11$	$p < .0001$
						WRAT R	$F(1,21) = .340$	$p < .0764$

CHAPTER IV

DISCUSSION

The results of this experiment revealed highly significant Group and Study x Group interaction effects. While a statistically significant study (longitudinal) effect was also found, the meaningfullness with respect to the combined groups can be questioned, given the nature of the interaction effect. As reference to Table 1 and Figure 1 will show, the within-group term (the group effect) is significant only for the retarded reader group, and only for this group in the Study 1 to Study 2 interval. A simple effects analysis revealed that the 2 groups differed significantly at all four levels of the Study variable. The level of significance of the $\underline{F}$ value in Study 1 was $\underline{p} < .0001$ while its value in Studies 2, 3, and 4 was $\underline{p} < .01$.

These results offer strong support for the conclusion that one skill (or combination of skills) in the array of phonetic analytic-synthetic abilities presumed to underlie the dependent measure lags behind in the development in the retarded reader group. This developmental lag phenomenon is graphically represented by that part of Figure 1 pertaining to Studies 1 and 2. Judging from the data in Figure 1, these abilities develop relatively early and reach their maximum for normal subjects at an early age. To the extent that retarded readers will catch up to normal readers on these abilities, they will do so in a relatively short time, in this case during the two-year period between Study 1 and Study 2.

The results, however, also offer strong support for the conclusion that retarded reading ability results from a deficit in one skill (or combination of skills) in the array of phonetic skills underlying the ability to spell with phonetic accuracy. The differences between the two groups closed dramatically between Study 1 and Study 2, but the differences remained statistically significant in Studies 2, 3, and 4. Therefore, it appears that retarded readers, while they are able to make up some of the "distance" between themselves and normal readers, do not make up all of it. At least one necessary component skill underlying phonetic spelling seems to be lacking throughout the age range of this study (7 years - 6 months to 11 years - 7 months).

Two important questions can be asked at this point. First, "Do retarded readers catch up because of late-developing phonetic subskills or because they learn to compensate for a basic deficit in one ability through development of alternative skills (perhaps visual)?" Second, "What are the phonetic analytic skills underlying the dependent measure?" and "Which of these subskills lag behind and which are simply not there (deficient)?" It is clear that the answers to each of these questions necessitates an investigation of the relative contribution of several phonetic analytic skills, such as short-term auditory verbal memory, sound segmentation, phoneme differentiation, sound blending, and knowledge of phoneme-grapheme correspondences to high scores on the dependent measure. If the array of skills used by two groups of readers, one normal and one retarded (both high on the dependent measure [PPAS]) was found to be strikingly different, this would suggest that retarded readers were in fact compensating rather than catching up. Additionally, the differentiation of those subskills which are 'lagging behind' from those which are deficient could prove most helpful in (1) designing remedial phonics teaching programs to assist the development of specific slow developing phonic skills and (2) prescribing non-phonics-based remedial programs for those children who could not (because of a permanent physiologically-based deficit) make use of them. While no attempt was made in the current study to identify the factors contributing to the dependent measure, this is clearly a desirable followup study to the present one.

One immediate implication of these results is that those researchers seeking to subcategorize retarded readers on the basis of their relative percents of phonetically accurate misspellings (Boder, 1971, 1973; Sweeney, 1976) should do so with children who are at least at the fourth grade level. Prior to this age, at least some children with relatively low scores on the dependent measure can be expected (on the basis of the present data) to make significant improvements on this measure. In the present study, no subject had a PPAS of less than 50% in Study 4. Even those retarded readers who continued to obtain reading and spelling achievement percentile scores in the 5-10 range, showed large increases in their PPAS by Study 4. The apparent failure of the retarded reader group to increase in their level of reading proficiency (relative to the normal group), as demonstrated by continued low reading achievement percentile scores in Study 4, together with their clear improvement on those skills needed to spell words phonetically, suggests that the substrate of component abilities underlying reading achievement is undergoing change during the primary grade school years. This interpretation of the results would agree with the findings of Calfee, Venesky, and Chapman (1969) and Gibson, Osser, and Pick (1963), who found similar developmental changes in reading subskills during this period.

The third hypothesis, which predicted this change from high correlations between PPAS and reading and spelling achievement in Study 1 to smaller (and fewer) correlations in the succeeding 3 studies was supported for the RR group but not for the NR group. For the NR group, the number of significant correlations in studies 3 and 4 actually exceeded those in the first 2 studies. These results are interpreted to mean that the absence of the necessary abilities to spell (and misspell) in a phonetically accurate manner is a good predictor of low reading and spelling achievement up to age of 9½ (the mean age for Study 2). Likewise the presence of good phonetic skills up to this age is correlated with high reading and spelling achievement. After the age of 9½, the situation becomes more ambiguous. There is some evidence to suggest that other higher-order skills must be mastered at these age levels (Frost, 1973), so that predicting reading achievement becomes more complex in the years in which studies 3 and 4 were carried out. The presence of good phonetic analytic skills is no longer reasonable assurance of high reading and spelling achievement.

As mentioned earlier, the only conclusions which can be drawn from the stepwise regression analysis is that PPAS, at best, is not a better predictor of reading and spelling achievement in Study 4 than are the tests of reading and spelling achievement themselves. There are difficulties in interpreting the results of the regression procedure much beyond this because of the high intercorrelations between many of the predictor variables. The second predictor "extracted" in the two variable model is not necessary the second best individual predictor, but rather the second variable which accounts for the largest portion of the variance not already accounted for by the first factor. For example, Table 4 shows WRAT Reading and then WRAT Spelling to be the components of the best predictor equation (using measures in Study 3) for predicting the reading achievement of a retarded reader in Study 4. However, Table 3 shows that WRAT Reading is significantly correlated with the dependent measure in Study 3 ($r = .49$, $p < .05$). Thus, because PPAS shares approximately 25 percent of the variance of WRAT Reading in Study 3, when the regression procedure extracted WRAT Reading first, it lowered the chance that PPAS would be the second factor chosen.

Conclusions and Implications

The purpose of the present study was to explore the relative degree of phonetic accuracy in misspellings of normal and retarded readers in second through sixth grade. It was hoped that, in doing so, it could be determined whether the evaluation of this skill (and the phonetic analytic-synthetic skills presumed to underlie it) seemed best to fit a defecit or maturational lag model. The findings clearly demonstrate that a combination of these 2 models is necessary to explain the performance of retarded readers on the dependent variable used in this study. Retarded readers clearly did improve in their ability to spell words that were phonetically accurate. Just as clear however, is the finding that retarded readers do not reach the level of normal readers before leveling off. Over studies 2, 3, and 4 the normal readers continued to be significantly more phonetically accurate spellers and over the same interval, neither group made any substantial improvement in this ability.

Further studies will be necessary to determine which phonetic analytic skill(s) underlie the dependent variable, and to assess the validity of an alternative compensation hypothesis which suggests that retarded readers may catch up by utilizing other compensatory skills which normal readers do not use.

The results additionally provided some support to the theoretical position which postulates that the subskills underlying reading performance during the primary school years are changing. It was particularly evident for the retarded reader group that the number and size of correlations between PA% and achievement measures were decreasing from Study 1 to 4.

Finally, the results failed to confirm the superior utility of the dependent variable in predicting future reading and spelling achievement when compared to standard measures of reading and spelling achievement.

APPENDICES

APPENDIX A

PHONETIC ACCURACY RATING FORM FOR JUDGES

PHONETIC ACCURACY RATING FORM FOR JUDGES

Correct Spelling: Enthusiasm

Syllable Structure: En thu si as m - 5 syllables

Pronunciation (Phonetic Structure): en thōō ze az em

Spelling Errors to be Rated: Phonetically accurate Syllables/Total Syllables

enthusiasam	5/5
enthuseasim	5/5
an/thos/the/as/ome	4/5
in/se/as/im	4/5
an/thou/si/as/um	5/5
en/thu/si/as/im	5/5

APPENDIX B

GUIDELINES FOR THE ANALYSIS OF SPELLING ERRORS

1. Score all misspellings for a given word before continuing on to the next page. This will help to insure continuity of your evaluations across all misspellings of a single word.
2. As best you can, divide the misspelled word into syllables which correspond with the <u>pronunciation guide word</u>. Do this by drawing a single verticle line between your syllables.
3. Now evaluate each syllable for its phonetic accuracy. The question you are asking is, "For each sound (phoneme) in this syllable, is the letter or letter combination used by the speller an allowable representation. You will be provided a copy of the 'Table of Common English Spellings' from <u>The Random House Unabridged Dictionary</u> to assist you in identifying allowable letter combinations for different phonemes.
4. Missing syllables should be scored as phonemically inaccurate.
5. Additional syllables should be scored and the score for the word, which will be a ratio of phonetically accurate to total syllables, should reflect the additional syllable in the denominator.
6. Syllables need not be in the correct sequence in order to be considered phonetically accurate. Two

syllables which have been reversed in the misspelled word should be considered as if they had appeared in the correct sequence.

7. Use your own common sense. Obviously, not all allowable letter combinations will be acceptable graphemic representatives of the phoneme, given the environment of that particular word. The 'Table of Common English Spellings' is meant as a guide, not a hard-and-fast code.

8. Whereever there was a disagreement on a syllable containing a schwa, that syllable was scored as phonetically accurate.

9. Syllable divisions were to be made rationally. (At times a rater had divided the words in a bizarre fashion so as to give the child maximal credit for the word).

10. It was permissable to consider a sound as being represented by letter combinations which crossed syllable boundaries. (Several children spelled commission [k mish n] with a final syllable, -tion).

11. The following gramphemes were considered acceptable equivalents of the paired letter(s): iy for /ī/; dj for /j/; re for er; and ents for ence.

APPENDIX C

TABLE OF COMMON ENGLISH SPELLINGS

Table of Common English Spellings

This table may be used to find the spelling of a word when only its pronunciation is known. For example, using the boldface, italicized equivalents in the *Spellings* column, the word pronounced (bit) would most likely be spelled bit. At the left, the first two columns show the relationships between the symbols used in this dictionary and those in the International Phonetic Alphabet (IPA). Under the Examples column are listed words that have in at least one of their pronunciations the symbol listed under the Dictionary Symbol column. For a complete table of IPA symbols, see page 1083.

Dictionary Symbol	IPA Symbol	Spellings	Examples
a	[æ]	a, a'a, ach, ag, ai, au, ui	hat, ma'am, drachm, diaphragm, plaid, draught, guimpe
ā	[eɪ, e]	a, ae, ag, ai, aig, ao, au, ay, é, è, ê, ea, ee, ee, eg, eh, ei, eig, eige, eigh, eilles, es, et, ey, ez	ate, Gael, champagne, rain, arraign, gaol, gauge, ray, exposé, suede, tête-à-tête, steak, matinee, née, thegn, eh, veil, feign, greige, sleigh, Marseilles, demesne, beret, obey, laissez faire
ä	[ɑ]	a, à, aa, ah, äl, as, at, e, ea, oi, ua	father, à la mode, bazaar, hurrah, calm, faux pas, éclat, sergeant, hearth, reservoir, guard
â(r)	[ɛ:(r)]	air, aire, are, ayer, ear, eer, e'er, eir, er, ere, ère, err, ey're, uerre	chair, doctrinaire, flare, prayer, wear, Mynheer, ne'er, their, mal de mer, there, étagère, Camembert, they're, nom de guerre
b	[b]	b, bb, bh	bed, hobby, bheesty
ch	[tʃ]	c, ch, che, tch, te, ti, tu	cello, chief, niche, catch, righteous, question, natural
d	[d]	d, 'd, dd, de, ed, ld	do, we'd, ladder, fade, pulled, should
e	[ɛ]	a, ae, ai, ay, e, è, ê, ea, eg, ei, eo, ie, oe, u, ue	any, aesthetic, said, says, ebb, manège, bête-noir, leather, phlegm, heifer, leopard, friend, foetid, bury, guest
ē	[i]	ae, ay, e, ea, ee, e'e, ei, eip, eo, es, ey, i, ie, is, oe, uay, y	Caesar, quay, equal, team, see, e'en, deceive, receipt, people, demesne, key, machine, field, debris, amoeba, quay, pity
f	[f]	f, ff, gh, lf, ph	feed, muffin, tough, calf, physics
g	[g]	g, gg, gh, gu, gue	give, egg, ghost, guard, plague
h	[h]	h, wh	hit, who
hw	[hw, ʍ]	wh	where
i	[ɪ]	a, e, ee, ei, i, ia, ie, o, u, ui, y	damage, England, been, counterfeit, if, carriage, sieve, women, busy, build, sylph
ī	[aɪ]	ai, ais, aye, ei, eigh, eye, i, ie, igh, is, uy, y, ye	faille, aisle, aye, stein, height, eye, ice, tie, high, island, buy, sky, lye
j	[dʒ]	ch, d, dg, dge, di, ge, gg, gi, j, jj	Greenwich, graduate, judgment, bridge, soldier, sage, exaggerate, magic, just, Hajji
k	[k]	c, cc, cch, ch, ck, cq, cqu, cque, cu, gh, k, ke, kh, lk, q, qu	car, account, bacchanal, character, back, acquaint, lacquer, sacque, biscuit, lough, kill, take, Sikh, walk, Iraq, liquor
l	[l]	l, le, ll, 'll, lle, sl	live, mile, call, she'll, faille, lisle
m	[m]	chm, gm, lm, m, 'm, mb, me, mh, mm, mn	drachm, paradigm, calm, more, I'm, limb, home, mho, hammer, hymn
n	[n]	gn, kn, mn, n, ne, nn, pn	gnat, knife, mnemonic, not, done, runner, pneumatic
ng	[ŋ]	n, ng, ngg, ngue	pink, ring, mahjongg, tongue
o	[ɒ]	a, ach, au, o, ou	wander, yacht, astronaut, box, cough
ō	[oʊ, o]	au, aut, aux, eau, eaux, eo, ew, ho, o, oa, oe, oh, ol, oo, os, ot, ou, ow, owe	mauve, ha[illegible], faux pas, beau, Bordeaux, yeoman, sew, mho, note, road, toe, oh, yo[illegible]rooch, dos-a-dos, depot, soul, flow, owe
ô	[ɔ]	a, ah, al, as, au, augh, aw, o, oa, ou, ough	tall, Uta[illegible]alk, Arkansas, fault, caught, raw, alcohol, broad, sought, fought
oi	[ɔɪ]	aw, eu, oi, ois, oy, uoy	lawyer, Freud, oil, Iroquois, toy, buoy
o͝o	[ʊ]	o, oo, ou, oul, u	wolf, look, would, could, pull
o͞o	[u]	eu, ew, ieu, o, oe, oeu, oo, ou, u, ue, ug, ui	maneuver, grew, lieu, move, canoe, manoeuvre, ooze, troupe, rule, flue, impugn, fruit
ou	[aʊ]	au, ou, ough, ow	landau, out, bough, brow
p	[p]	p, pp	pen, stopper
r	[r]	r, re, 're, rh, rr, rrh, wr	red, pure, we're, rhythm, carrot, catarrh, wrong
s	[s]	c, ce, ps, s, 's, sc, sch, se, ss	city, mice, psychology, see, it's, scene, schism, mouse, loss
sh	[ʃ]	ce, ch, chsi, ci, psh, s, sch, sci, se, sh, si, ss, ssi, ti	ocean, machine, fuchsia, special, pshaw, sugar, schist, conscience, nauseous, ship, mansion, tissue, mission, mention
t	[t]	bt, cht, ct, ed, ght, phth, t, 't, te, th, tt	doubt, yacht, ctenophore, talked, bought, phthisic, toe, 'twas, bite, thyme, bottom
th	[θ]	chth, th	chthonian, thin
th	[ð]	th, the	then, bathe
u	[ʌ]	o, oe, oo, ou, u	son, does, flood, couple, cup
û(r)	[ɜr, ɝ]	ear, er, err, eur, ir, or, our, ur, urr, yr, yrrh	learn, term, err, poseur, thirst, worm, scourge, hurt, purr, myrtle, myrrh
v	[v]	f, ph, v, ve, 've, vv	of, Stephen, visit, have, we've, flivver
w	[w]	o, ou, u, w	choir, ouija, quiet, well
y	[j]	i, j, y	union, hallelujah, yet
yo͞o	[ju, ɪu]	eau, eu, ew, ieu, iew, u, ue, ueue, yew, you, yu	beauty, feud, few, purlieu, view, use, cue, queue, yew, you, yule
z	[z]	s, 's, sc, se, ss, x, z, ze, zz	has, who's, discern, raise, scissors, anxiety, zone, raze, dazzle
zh	[ʒ]	ge, s, si, z, zi	garage, measure, division, azure, brazier
ə	[ə]	a, à, ai, e, ei, eo, i, ia, io, o, oi, ou, u, y	alone, tête-à-tête, mountain, system, mullein, dungeon, easily, parliament, legion, gallop, porpoise, curious, circus, Abyssinia
ər	[ər, ɚ]	ar, er, ir, or, our, ur, ure, yr	liar, father, elixir, labor, labour, augur, future, martyr

APPENDIX D

RAW DATA

STUDY: Phonetic Accuracy in Spelling of Normal and Retarded Readers

DEPARTMENT OF PSYCHOLOGY

DATA SHEET

DATE

Retarded Reader Group

Subject Number	Study 1 Totl Syll	Study 1 PA%	Study 1 WRAT Read	Study 1 WRAT Spel	Study 1 MAT Read	Study 1 MAT WK
1	20	27.3	14	19	15	8
2	18	7.1	21	14	10	6
3	30	47.8	47	66	miss	miss
4	23	30.8	19	23	15	30
5	21	27.3	10	13	33	30
6	17	36.4	14	19	5	5
7	23	46.1	27	39	12	25
8	6	00.0	21	19	5	18
9	12	10.0	30	21	15	25
10	16	50.0	34	42	2	4
11	37	5.0	77	39	5	35
12	21	21.4	12	18	20	12
13	26	58.3	23	34	2	12
14	18	33.3	23	32	20	15
15	10	[illegible]	21	25	15	15
16	23	9.1	30	19	5	3
17	2	00.0	10	7	2	6
18	14	[illegible]	10	13	20	2
19	34	65.0	45	55	20	35
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						

Subject Number	Study 2 Totl Syll	Study 2 PA%	Study 2 WRAT Read	Study 2 WRAT Spel	Study 2 MAT Read	Study 2 MAT WK
1	30	38.1	13	13	2	2
2	48	69.2	53	39	22	35
3	39	83.3	53	53	5	30
4	37	69.2	18	23	4	25
5	54	58.3	21	16	25	18
6	64	86.0	39	27	9	10
7	9	40.9	27	16	4	5
8	34	85.0	32	23	12	18
9	28	70.6	10	18	7	2
10	40	81.3	37	53	15	20
11	48	79.4	30	12	2	42
12	61	77.2	82	39	28	50
13	59	72.4	37	58	25	55
14	37	82.3	47	27	20	25
15	64	80.9	59	39	30	35
16	59	66.7	39	39	6	35
17	20	54.5	13	9	2	2
18	33	50.0	58	25	55	30
19	37	78.9	47	25	14	12

Subject Number	Study 3 Tot Syl	Study 3 PA%	Study 3 WRAT Read	Study 3 WRAT Spel	Study 3 MAT Read	Study 3 MAT WK
1	37	50.0	4	5	16	18
2	79	86.0	53	47	25	40
3	64	72.2	27	39	13	30
4	58	71.4	25	14	8	10
5	37	70.0	18	7	[illegible]	4
6	97	89.1	68	23	13	25
7	58	67.5	14	13	20	5
8	64	64.4	21	21	23	25
9	34	72.7	12	10	5	2
10	74	76.6	45	50	25	65
11	64	92.1	42	23	2	30
12	90	92.4	82	50	35	58
13	67	78.4	53	37	18	38
14	74	83.7	39	61	25	25
15	74	87.2	30	61	10	30
16	59	64.3	69	42	2	25
17	34	61.9	9	10	6	2
18	58	33.3	61	19	15	50
19	51	88.5	87	19	40	70

Subject Number	Study 4 Tot Syl	Study 4 PA%	Study 4 WRAT Read	Study 4 WRAT Spel	Study 4 MAT Read	Study 4 MAT WK
1	64	53.3	9	7	4	3
2	84	79.4	47	53	33	13
3	67	56.8	39	30	8	45
4	61	94.3	45	12	10	38
5	43	86.9	16	5	10	18
6	64	90.0	58	32	25	13
7	61	74.4	14	16	12	15
8	64	72.5	21	18	20	20
9	34	60.0	6	5	2	[illegible]
10	64	88.0	39	25	58	58
11	58	94.1	23	16	10	[illegible]
12	97	95.7	95	84	60	[illegible]
13	94	77.1	75	32	17	38
14	74	92.3	52	39	35	40
15	97	96.3	59	30	17	55
16	97	75.0	37	73	8	18
17	36	68.2	7	4	2	2
18	70	50.0	50	25	20	45
19	70	86.5	61	37	58	78

Phonetic Accuracy in Spelling of Normal and Retarded Readers

STUDY

DEPARTMENT OF PSYCHOLOGY

DATA SHEET

DATE

Normal Reader Group Subject Number	STUDY 1 Totl Syll	PA%	WRAT Read	WRAT Spel	MAT Rea	MAT WK	STUDY 2 Tot Syl	PA%	WRAT Read	WRAT Spel	MAT Rea	MAT WK
20	54	72.7	99	84	78	65	67	81.3	99	82	35	65
21	36	66.7	96	59	75	80	74	84.6	99	93	65	70
22	64	75.0	58	84	50	30	64	61.3	96	73	35	75
23	36	80.0	94	81	50	65	64	83.3	82	66	70	87
24	36	72.7	59	59	65	80	58	79.3	45	50	25	45
25	30	71.4	88	75	65	55	79	76.1	86	68	42	45
26	22	[illegible].5	86	63	65	65	54	60.3	66	45	50	45
27	30	50.0	75	42	80	63	58	84.4	68	50	75	70
28	30	25.0	79	61	70	60	61	82.4	82	73	30	78
29	37	62.5	95	90	50	60	64	77.1	91	79	55	78
30	61	83.3	96	84	65	60	97	85.7	93	86	55	50
31	64	81.0	96	96	[illegible]	93	97	84.2	99	93	35	68
32	37	70.9	58	47	55	20	67	83.2	53	68	40	55
33	64	89.0	99	84	88	85	87	80.3	95	79	65	78
34	64	84.3	99	99	80	98	97	90.8	99	99	80	78
35	70	87.5	99	99	85	91	97	96.9	99	99	95	78
36	84	74.5	96	96	55	80	97	95.6	99	99	53	80
37	23	miss	94	84	62	65	97	84.0	99	90	50	55
38	79	77.2	miss	99	7[illegible]	88	84	75.2	99	79	35	58
39	43	64.7	82	81	70	85	64	72.2	82	73	50	60
40	36	76.5	94	81	60	65	70	87.3	91	68	22	50
41	37	80.0	90	84	69	75	64	78.0	86	61	32	53
42	34	72.2	84	66	50	35	61	60.6	61	66	25	30
43	27	62.5	99	75	75	65	79	82.7	99	82	60	78

Normal Reader Group Subject Number	STUDY 3 Tot Syl	PA%	WRAT Read	WRAT Spel	MAT Read	MAT WK	STUDY 4 Tot Syl	PA%	WRAT Read	WRAT Spel	MAT Read	MAT WK
20	97	86.4	97	77	45	70	97	92.3	98	81	50	75
21	97	90.0	92	84	80	68	97	87.1	96	96	[illegible]	78
22	97	94.5	86	70	73	65	97	90.4	75	47	80	55
23	97	94.9	99	94	75	83	97	99.9	[illegible]	96	[illegible]	[illegible]
24	58	35.[illegible]	53	82	23	50	84	79.5	53	47	58	60
25	54	84.2	77	77	18	58	97	88.2	9[illegible]	96	32	55
26	67	87.5	97	45	40	70	70	81.3	99	45	45	75
27	97	92.3	95	61	65	55	97	96.1	66	47	93	60
28	67	96.6	92	70	73	85	84	84.0	73	45	85	80
29	70	75.7	97	70	93	60	90	73.3	99	66	70	65
30	97	94.2	97	77	20	50	97	87.5	87	88	50	65
31	97	97.4	96	96	70	75	97	100.0	95	[illegible]	82	96
32	74	87.2	88	61	50	58	97	90.0	87	[illegible]	45	50
33	97	96.2	92	70	93	83	97	95.7	99	70	70	55
34	97	91.7	98	99	75	65	97	94.4	99	99	55	55
35	97	96.2	99	99	93	98	miss	miss	99	99	85	68
36	97	95.5	99	99	75	68	97	100.0	99	99	30	[illegible]
37	97	88.9	97	96	60	45	97	85.7	95	93	55	55
38	97	92.1	99	94	40	58	97	100	99	96	55	65
39	61	55.2	63	47	58	40	97	57.9	66	53	60	55
40	82	86.5	70	53	28	50	97	94.4	84	88	38	35
41	58	85.7	82	61	20	45	64	96.8	82	39	65	60
42	67	90.9	88	53	33	45	97	78.6	87	47	30	28
43	97	100	99	99	65	70	97	100	99	93	82	78

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