SPELLING STRATEGIES OF PRIMARY SCHOOL CHILDREN AND THEIR RELATIONSHIP TO THE PIAGETIAN CONCEPT OF DECENTRATION

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ABSTRACT

There were two purposes for this study: 1) to determine whether children's spelling strategies changed according to the grade level of the child and the particular demands of the kind of word the child was trying to spell, and 2) to examine the relationship between children's spelling strategies and their cognitive development measured in terms of Piaget's notion of decentration.

Two lists of words, each of which contained three exemplars of five spelling categories (Lax Vowel, Tense Vowel, Past Tense Marker, Consonant Doubling, and Vowel Extension) were administered to 15 children each from grades one through four. Appropriate scores based on specific spelling strategies were assigned to each child's attempts. A two-way hierarchically partitioned analysis of variance was performed on these scores to determine the effects of grade, spelling category, and their interaction. Frequency counts of the use of specific strategies were tabulated by category for each grade in order to provide more descriptive data about what the children were trying to do.

A decentration test battery (specially constructed for this study) was also administered to the 60 children. This instrument was divided into seven specific areas:

conservation of number, mass, continuous quantity, weight and volume, class inclusion, and the Picture Integration Test (Elkind, in press). A canonical correlation and two R factor analyses (one with grade level controlled) were performed on the children's five spelling category scores and their scores on the seven decentration tasks in order to determine if there was a relationship between these two sets of variables.

The results of the analysis of variance indicated that the effects for grade, category, and their interaction were significant ($p<.01$). The findings suggested a progressive pattern of spelling strategies dependent upon both the child's familiarity with written language and his intellectual maturity. However, little evidence was found for some of the transitional spelling strategies noted by previous investigators. This may have been due to the immaturity of the second grade sample.

The canonical correlation between the spelling and decentration variables was significant ($r = .67$, $p<.01$). The first factor analysis clearly indicated a two factor solution. All the decentration variables loaded significantly on the first factor, while none of the spelling variables loaded on this factor. The pattern of the second factor was exactly the reverse. However, the two factors were significantly correlated ($r = .56$, $p<.01$). Partial correlations with grade level control was used to general a second factor analysis. The factor

patterns remained the same, and the correlation between the two factors, though somewhat reduced remained significant ($r = .36$, $p<.01$).

It was concluded from these findings that both a child's familiarity with written language and his ability to decenter significantly contribute to his conceptual understanding of the English orthographic system.

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CHAPTER I

INTRODUCTION

Spelling Strategies

Recent theoretical analyses of English orthography (Chomsky, 1970; Chomsky & Halle, 1968; Venezky, 1967; Weir & Venezky, 1968) have challenged the idea that English spelling is an arbitrary and noticeably irregular system based upon phoneme-grapheme correspondences. It has been argued that, to the contrary, the orthography becomes quite regular and understandable when examined in terms of a total language system, involving deeper levels of phonological, morphological, and syntactic processing. When this model has been applied to the study of children's spelling (Beers, 1974; Henderson and Beers, 1974; Read, 1971, 1973), the findings have tended to show that their attempts follow an orderly sequential progression depending upon both the child's experience with written words and his ability to integrate several kinds of information into a total orthographic system.

The first major purpose of this study was to extend this examination of children's spelling patterns. In their separate studies Beers, Henderson, and Read had dealt exclusively with preschool, first grade and second grade children, and they had focused primarily on lax

vowel, tense vowel and morphological marker spelling patterns. The present study has attempted to elaborate and extend this line of research in two ways: 1) by examining the responses of third and fourth grade children as well as first and second graders, and 2) by adding two new classes of exemplars, Consonant Doubling and Vowel Extension, to the already mentioned Lax Vowel, Tense Vowel and Morphological Marker categories. It was believed that these new categories would require more sophisticated strategies on the part of the speller if he were to handle them correctly. The criteria used for scoring the misspellings was a slightly modified version of the scale employed by Beers (1974).

It was believed that an analysis of variance of this data would provide a statistical test of the following hypotheses:

1) that there would be differences in the mean scores of the four grades over all the categories together,

2) that there would be differences in the mean scores for each category over all the grades together,

3) that there would be an interaction between grade level and spelling category.

Frequency counts of the use of each strategy level were tabulated for each grade for each category. It was felt that these would provide descriptive data that would help make the results of the analysis more understandable.

Spelling and Decentration

The generative-progressive model of children's spelling attempts developed and investigated by modern researchers seems to fit very well with Piaget's more general theory of cognitive development, since Piaget also emphasizes the need for the organism to structure its experience in order to comprehend it. Piaget further argues that there are qualitatively different stages of development, and that entrance into a given stage depends upon the kinds of structures a child is able to coordinate. The differences in cognitive functioning between Piaget's preoperational and concrete operational stages seem particularly relevant to the study of children's misspellings for two reasons: 1) the change from preoperational to operational thinking typically occurs between the ages of five and eight, that is, during that period in which the child is usually expected to begin to read and write, and 2) the coordination of structures available to the child might very well affect the way he perceives the structural and phonetic relationships believed to underlie orthographic regularity.

Thus the second major purpose of this investigation was to explore the relationship between children's spelling strategies and their cognitive development. Accordingly, performance on a battery of Piagetian tasks (specially constructed for this study) was also measured. A canonical correlation and two R factor analyses (one

with grade level controlled) were performed on the scores of the subjects for each of the five spelling categories and the seven Piagetian tasks. It was believed that these would provide statistical and descriptive information in regard to the general hypothesis that strategy ratings for the spelling categories would be correlated with a child's ability to decentrate, as measured by these tasks.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The present study involves two distinct areas of investigation, recent studies of English spelling and Piaget's theory of cognitive development, which, it will be shown, share some basic theoretical assumptions and practical implications. In order to do justice to each of these areas, it will be necessary first to review them separately, and then to take up those studies which have dealt with the possible relationships between a child's ability to learn the concepts underlying written language and his stage of cognitive development.

Most spelling research has focused on methods of instruction. Several general reviews of this research have been written by Fitzgerald (1951), Petty (1964), and Horn (1960, 1969). However, the present study is concerned primarily with how children attempt to spell different types of words, that is, with the conceptual basis behind English orthography. Thus it seems appropriate to review research that has dealt with what have typically been considered the more difficult aspects of English words and their relationship to the English writing system. Cahen, Crawn, and Johnson (1971) provide an

excellent review of such research, and their article will serve as a major secondary source of information for the initial sections of the following discussion. The subsequent examination of recent literature will concentrate on more theoretical approaches to the underlying system of English orthography and on efforts to discover the sequential stages of a child's development as he gradually constructs and reconstructs a systematic approach to English spelling, enabling him to deal with the written word in a correct and more efficient manner. The work of Beers (1974), Chomsky (1970), Chomsky and Halle (1968), Henderson and Beers (1974), Read (1971, 1973), Venezky (1967), and Weir and Venezky (1968) will form the basis of that examination.

In regard to stages of cognitive development the discussion will concentrate almost exclusively on Piaget's, and subsequently Elkind's, description of essential differences between preoperational and operational perception and thought that are most relevant to the child's understanding of the conceptual basis of English orthography (Elkind, Anagnostopoulou, & Malone, 1970; Elkind, Koegler, & Go, 1964; Elkind & Scott, 1962; Elkind & Weiss, 1967; Piaget, 1966, 1967, 1968, 1973; Piaget & Inhelder, 1969).

It is by no means within the scope of this study to review the vast bulk of research generated by Piaget's theory even within the narrow range of transition from preoperational to operational thinking. On the other hand,

it will be necessary to review the significant interpretations suggested by Bruner, Olver, Greenfield, et al. (1966) and Flavell (1971) which in some ways question the underlying model Piaget has developed.

Finally, a brief section will be devoted to the all too scarce research which has attempted to relate these two major areas, and a rationale will be provided for this investigator's central hypothesis: that the acquisition of written word knowledge is a developmental, conceptual process, and as such it will be significantly correlated to Piaget's stages of cognitive development.

Spelling Literature

Early Descriptive Studies

Many early spelling difficulty studies were simply tabulations of misspelled words from the writings of elementary school children. These compilations (for example, Breed, 1925; Fitzgerald, 1932; Johnson, 1950) often ignored the frequency of occurrence of the words in children's writing. Thus, on the one hand, a high frequency word might appear on the list, even though it was spelled correctly much more often than incorrectly. On the other hand, a word might be listed in the top ten percent of misspelled words when it occurred in less than ten percent of the children's writing. Furthermore, no reason was postulated as to why the particular words were misspelled, nor did the compilations suggest any predictions

about other possible misspelled words.

Some attempts were made to identify the difficult parts of words. Gates (1937) identified such parts for elementary school children, reporting both errors and their percentage of frequency of occurrence within words, but he did not generalize to any error types. Fitzgerald (1958) examined his own previous list and its overlap with other lists. He also identified parts of words that caused the most difficulty. Again, however, the work remained essentially descriptive: though he found, for example, that capitalized words and possessives were often misspelled, Fitzgerald ignored the question of how they were misspelled and why.

Kyte (1958) and Mendenhall (1930) did categorize error types and did try to analyze the errors causing misspellings. Mendenhall suggested a predictive value for such an analysis. For instance, he predicted that a word containing a diphthong would be more difficult to spell than a word without one. Gibson (1969), using a computer-assisted analysis of high school students' spelling, found four main categories of misspellings: additions, omissions, substitutions and inversions. Again, she failed to indicate why these types of errors occurred. Furthermore, such deductive analyses of error types have little predictive value. Though diphthongs may account for a number of spelling errors, this does not indicate that every word containing a diphthong will be difficult to spell, and

though omissions or additions of letters may be common error types, in general, it is impossible to predict from these analyses where and in what words these types will occur.

Phoneme-Grapheme Correspondences

Another line of research examined spelling in terms of the regularity of the correspondences between individual sounds in a word (phonemes) and the symbols used to represent them (graphemes). Atkins (1926) examined the Thorndike-Lorge list of the 2,500 most frequently used English words and concluded that more than half the letter combinations did not have regular phoneme-grapheme correspondences. Petty (1955, 1957) attempted to determine which phonemes contributed to spelling difficulty. Using pairs of words of equal length, one spelled correctly by less than 70% of the eighth graders tested, and the other spelled correctly by over 80% of the same sample, and then, by doing separate analyses across phonemes, he found no significant differences between the easier and the more difficult list. Nine phonemes, present in words of persistent difficulty, were then investigated by studying 100 words from the original list that contained all nine phonemes in all possible syllable positions. These phonemes were all spelled correctly more frequently than not. Petty concluded that such an analysis was too simplistic to shed any significant light on the problem of spelling difficulty.

Hanna and Moore (1953) provide the first close analysis of letter-sound combinations in English words. Analyzing 3,000 words from a spelling list, they concluded that 80% of the phonemes were consistently represented by the same letter or letters in more than half the occurrences of these phonemes in words.

Thomas
Ernest Horn (1957), on the other hand, disagreed with this analysis. He argued that in his own sample of 10,000 words over one-third of the words had more than one acceptable pronunciation. Thus many of the regular correspondences in the Hanna and Moore study would be irregular in terms of different dialects or variations of within-dialect pronunciation. They also failed to explain the presence of silent letters in over 50% of the words in the average American dictionary. Horn therefore argued for a much lower proportion of regular phoneme-grapheme correspondences than did Hanna and Moore.

Hanna, Hodges, Hodges, and Rudorf (1966) used a computer to analyze 17,000 of the words in the corpus of Thorndike and Lorge (1944), using the pronunciations in Webster's New Collegiate Dictionary (1961). In this study position of the sound within the syllable and the presence or lack of stress on the syllable were also considered. They concluded that with these added considerations almost all the consonant sounds and some vowel sounds were represented by one grapheme over 80% of the time. Then, reversing the direction of their procedure, Hanna et al.

used their regular sound-to-letter correspondences to predict the spelling of the 17,000 words on the Thorndike and Lorge (1944) list. They reported that 49% of the words could be spelled correctly using this method.

Several major objections have been raised in regard to the Hanna et al. work. Roberts (1967) objected to the use of the Thorndike-Lorge corpus which lists, for the most part, nonderivational and uninflected forms of words. Roberts also charged that the Webster's New Collegiate Dictionary (1961) poorly represents actual American speech. Other objections included failure to use a pronunciation system that represents a single English dialect, use of arbitrary syllable divisions, ad hoc definitions of phonemes, etc. These criticisms, like Horn's to the Hanna and Moore (1953) study, tend to suggest a lower estimation of regularity than the results would indicate. By far the most telling objections, however, suggest the very opposite. Reed (1967) noted several problems with the study:

> (1) failure to view English phonology consistently as part of the total structure of English grammar, (2) failure to formulate an adequate theory of the relationship between dialect diversity and the system of English spelling, and (3) too great dependence on the capacity of the computer, which leads to many limitations in linguistic research [p. 208].

Reed's first two objections are most important because they suggest a flaw common to all of the spelling research thus far reviewed: a tendency to examine parts of the total language system in isolation, and thus to

ignore the complex interactions of semantic, grammatical, phonological and orthographic systems which a child must utilize simultaneously if he is to master English spelling. Thus far the literature, in accordance with a strictly behavioristic approach to language and learning, had looked only at the quantitative output and viewed spelling from a very narrow, surface-oriented position. The studies that are reviewed below have tried to approach spelling in terms of the integration of several deeper, developing levels of processing.

Theoretical Views of English Orthography

Venezky (1967) and Weir and Venezky (1968) made two major contributions to the study of English orthography. Through use of a computer analog Venezky (1967) developed a much more sophisticated interpretation of the regularity of the surface aspects of English spelling-sound correspondences. At the same time he postulated a system of graphemic, phonemic, and morphemic interrelationships which indicate an even higher degree of regularity in English spelling when all these factors are taken into account.

In discussing the surface patterns of the orthography Venezky (1967) argued that graphemic constraints limit the possible letter combinations that are allowable in English spelling. For instance, no English word begins with rs, while more importantly, in terms of regularity analysis, v can never be the final grapheme in an English word. (Thus have and not hav.)

Venezky continued his analysis of surface patterns by developing the idea of relational units that dictate the correspondence between graphemes and phonemes. These he considered fairly arbitrary. Thus t represents the first phoneme in tickle, but th, a separate relational unit, represents the first phoneme in thief. Venezky made the important discovery that such relational units can have either simple or compound functions in terms of the sounds they represent, independent of the number of graphemes involved, and that this adds to the regularity of the system. For example, th in bathe has two graphemes, but serves a simple function, thus the pronunciation of the a is tense. On the other hand, x serves a compound function, representing the phonetic combination /ks/. Thus the lax pronunciation of the a in taxi.

Finally, Venezky's most important contribution to the understanding of the regularity of the surface structure of English spelling was his in-depth explanation of the influence of orthographic markers. These are letters that are not pronounced but which affect the pronunciation of other graphemes in a word. For example, the e in cape, the second e in creep and the a in float all influence the pronunciation of the preceding vowel. In a somewhat different case, the e in noticeable marks the c as being pronounced like /s/ rather than like /k/ as it would be in a position directly preceding a, as in cap, care, etc. Relational units can at times function as markers as well

as units in their own right. The i in city, for example, marks the pronunciation of the c as /s/ rather than /k/ as well as serving its own relational function.

It is evident that Venezky's surface analysis alone demonstrated the existence of many regular subpatterns within the overall pattern of English orthography. But he also went on to argue that the predictability of the pronunciation of written words is further enhanced by consistent interactions with deeper levels of processing. Venezky suggested a four-stage process of interaction. First, a morphemic boundary scan determines the number of morphemes (meaning bearing units) in a word and their boundaries. Thus anthill is recognized as having two morphemes, and, since the boundary occurs between the t and the h, they are recognized as separate relational units rather than as the th unit as in thief. At the next stage the relational units are mapped into their phonemic representations in a simple one-to-one match. At this point Venezky postulated a morphophonemic level in which phonological rules, related to concerns like syllabication and stress, as well as semantic and syntactic factors, modify the previous mappings. Finally, the word is given its phonetic representation or its typical pronunciation.

As an example, the word signing can be taken through its processing. First, the initial scan reveals two morphemes sign + ing. Next the relational units are mapped into their respective phonemes /sIgn/ + /Ing/. On the

morphophonemic level phonological habits (for example, /g/ preceding /ŋ/ at the end of a word, or at the end of a syllable followed by a stressed syllable, becomes silent) operate to produce /sɑɪnɪŋ/ as the final phonetic representation.

Venezky's use of a morphophonemic level in combination with surface level patterns substantiated the idea that the pronunciation of written words can be predicted with much more regularity than simple letter-sound correspondences allow. Furthermore, such a system permits the retention of meaning bearing morphemic units in words (for example, the ed in cramped) while still explaining the consistency of their pronunciation.

Venezky's model, though incorporating deeper levels of processing, still remained close to the surface level of language. A grapheme-phoneme match, though by no means the only level of processing, was still an essential one, and the influence of one grapheme upon the pronunciation of others, as in the case of orthographic markers for example, still remained a surface level phenomenon.

In contrast, Chomsky (1970) and Chomsky and Halle (1968) argued that English orthography is a near optimal system for representing the relationship between sound and meaning. They asserted that this system is based, not on a set of structural rules describing English orthography, but rather on an extensive set of deeper, abstract phonological rules which, when applied by the reader to the graphic

representation, generate the word's pronunciation.

In order to develop such a theory, Chomsky and Halle argued that each word has an internalized lexical representation which is essentially a collection of distinctive phonetic, semantic and syntactic features. This representation 1) varies little from speaker to speaker, even across dialects; 2) is nearly perfectly represented by the orthography, and, most importantly, 3) contains only and all that information not predictable by phonological rules. A word's spelling thus provides just the essential information needed to predict its final pronunciation. Of course, the rules themselves may be highly complex, and may result in a phonetic representation with little one-to-one resemblance to the word's abstract lexical form. However, Chomsky and Halle stated that the final form is totally predictable in terms of the rules applied, and that each mature speaker-listener has a complete intuitive understanding of these rules and their applications. A brief examination of one of Chomsky's (1970) examples of how a lexical representation arrives at its final phonetic representation will illustrate the complexity of the phonological rule system, and provide an example of its systematic application.

The example is Chomsky's derivation of the word courageous:

	Phonetic Description	Phonological Rules
1)	kor œ́ge ɔs	lexical representation

	Phonetic Description	Phonological Rules
2)	kor$\acute{æ}$gəs	stress rule
3)	kor$\acute{æ}$jəs	velar softening
4)	kor$\acute{æ}^{v}$jəs	tensing
5)	kor$\acute{æ}$yjəs	diphthonization
6)	kor$\acute{ey}$jəs	vowel shift
7)	kor$\acute{ey}$jɔs	e-elision
8)	kɔr$\acute{ey}$jəs	vowel reduction

He began with the assertion that line one is simply the lexical representation of the noun courage /kor$\acute{æ}$ge/ followed by the adjectival ending /ɔs/. Next, a rule of stress assignment puts the stress on the antepenultimate cluster, since the final two clusters are weak. Line three reflects the effects of a velar softening rule which softens the velar stop /g/ to /j/ before a non-low front vowel /e/, but leaves the velar stop /k/ before the back vowel /o/. Lines four, five and six represent a series of rules which affect the pronunciation of English vowels, depending on considerations of stress contours, syllabication, etc. Lines seven and eight show the effects of very general rules in English which elide the pronunciation of /e/ in the final position of an item (here the representation for the noun element courage) and reduce unstressed vowels to schwa, /ə/.

By relying on such a system of phonological rules, Chomsky was able to argue that Venezky's concerns for surface structure and a level of phonemic representation

were unnecessary, and essentially a "methodological artifact" of modern linguistics. The differences between those two viewpoints becomes apparent by contrasting their approaches to orthographic markers. Weir and Venezky (1968) argued that markers are part of the surface structure:

> Markers are an integral part of the English orthography; they are used specifically to point out the correspondence of other spelling units and do not, themselves, correspond to sounds. To neglect this distinction is to neglect much of the patterning in the spelling to sound relationship [p. 199].

Chomsky, on the other hand, did not regard markers as orthographic phenomena at all, but rather as one part of the abstract lexical representation which had become 'silent' through the application of specific phonological rules, like the e-elision rule cited above.

Chomsky's theory also implied an historical explanation of the variations between abstract lexical representations and final phonetic pronunciations. The phonological rules he discovered seem to reflect historical changes in pronunciation which developed after the orthographic system had been greatly standardized. Thus, lack of a direct phonetic correspondence (that is, the difference being only one of tenseness) between the tense a in sane and the lax a in sand is due to a later shift in pronunciation (Great Vowel Shift) rather than to an orthographic anomaly. Furthermore, Chomsky argued, since variations between dialects are essentially variations in phonological

rules, lexical representations and, consequently, the orthography, are extremely well suited to preserving meanings across dialects, because they allow for the generation of differing pronunciations as long as each pronunciation fits into a particular dialect's overall phonological system.

As parsimonious as Chomsky's theory seems to be, it does have one major difficulty. Chomsky constructed his model based upon the knowledge of the ideal, mature speaker-listener-reader-speller. Thus the orthography is optimal for someone with a thorough understanding of his language's phonological rule system. However, as Chomsky (1970) admitted, children are asked to deal with orthography before they have fully mastered the phonology. Furthermore, as Chomsky (1970) also pointed out, children seem to be much more attuned to phonetic differences than adults and are concerned with a level of phonetic detail that is of no interest to the mature language user. Similarly, abstract lexical representations cannot just suddenly come into being, especially if the language's phonology has yet to be totally mastered. Chomsky (1970) suggested that lexical spellings are based on previous knowledge of learned words, and that

> It may very well be that one of the best ways to teach reading is to enrich the child's vocabulary, so that he constructs for himself the deeper representations of sound that correspond so closely to the orthographic forms [p. 18].

But this response still leaves the developmental question

of specifically how the child goes about doing so largely unanswered.

The theoretical work on orthography has several important implications for the present study. Both Venezky and Chomsky concluded that English spelling is a highly regular system, and that the rules that govern it are not always realized at the surface level of production. Chomsky's model also suggests that a child's knowledge of phonological rules will have a direct bearing on his understanding of how words are spelled. In order to understand language fully the child must, over time, construct, test, and then adjust a set of internalized phonological rules. In learning to spell the child utilizes these rules to arrive at the underlying lexical representations which are so closely mirrored in the orthography. Thus a child's spelling is neither random, nor simply the result of overlearning, but a developing system of applying internalized abstract rules about language to his spelling. Several recent studies have attempted to explore this developmental aspect.

Spelling Strategies in Children

Read (1971) examined the spontaneous spellings of preschool children. He concluded that though the spellings were not correct, they seemed to be based on implicit knowledge of a hierarchy of abstract phonological features such as tenseness, nasality, location, etc. What was also

very striking was that these children, working independently, arrived at very similar systems and spellings. For example, Read found that in attempting to represent lax vowel sounds the children typically selected the tense vowel closest to it in terms of articulating position, so that fish was spelled fes, fell was spelled fall, etc. Such pairings are not only quite regular, but also quite logical alternatives made incorrect by the fact that the Great Vowel Shift occurred after the major standardization of English spelling.

In a later study, Read (1973) asked six year olds, seven year olds, and adults to judge which of two words was most like a third word. The only difference between the words was either the height of articulation or tenseness in the vowels. Again Read found that the children's responses were not random, but based on phonological principles. Overall, the children based the greater number of their judgments of similarity on tenseness rather than height, corresponding to the adult pattern. However, he also discovered that the six year olds judged tenseness a more salient feature for high vowels, while using height as the criterion for mid vowels. Read's results imply a systematic change in strategy probably due to a growing maturity in phonological judgments related to increased experience with both spoken and written language and beginning reading instruction.

Henderson, Estes, and Stonecash (1972) examined the written stories of first graders in Language

Experience Approach reading classes. They divided their sample into low, middle and high groups. Like Read they found a hierarchy of spelling strategies. The low group used a letter-name strategy (for example, cake might be spelled kak) while the middle group characteristically employed lax vowels, though not in the patterns Read had discovered. The high group showed awareness of marking patterns and some morphophonemic considerations. Unlike Read, however, they did not find the later transitional stage in which previous adjustments of lax vowel spellings affect the tense vowels (for example, table is spelled tebl).

Henderson and Beers (1974) followed the previous research with a longitudinal study of the spellings in the spontaneous writings of children in one first grade classroom. They specifically examined lax and tense vowels, morphological markers (like the past tense marker ed), orthographic markers, and selected consonants. By collecting the writings over a six month period, they were able to observe each child's changes in strategy as he tried to adjust his writing according to what he was learning about how meanings, sounds and spellings interact. Henderson and Beers noted three apparent stages of development. The first stage was characterized by letter-name strategies and a dependence on articulatory features for the lax vowels, very similar to the pattern Read noted. During the second stage the children began to treat letters as symbols for sounds not

restricted to those found in their names. There was a movement away from tense vowel substitution toward substituting a lax vowel that is higher and further back than the tense vowel (for example, sledding, first spelled sladeg, was then spelled slideg). In the last stage the children began to use orthographic markers and morphological units in their creative writing. Henderson and Beers concluded that the children used any pertinent information they had available—whether phonological, morphological, syntactic or orthographic—in their attempts to spell the words in their spontaneous writings. Furthermore, the systematic change in strategies over time indicated that the children were willing and able to make hypotheses about spelling and re-adjust their ideas as more information became available. Chomsky's model of a generative, rule-based system seemed to be confirmed, though the children used more than just phonological information.

Beers (1974) attempted to validate some of the sequential spelling strategies discovered in the preceding literature. He presented one fixed list of twenty-four words to first and second graders once a month over a five month period, using two monosyllabic exemplars of high and low frequency 'short' and 'long' a, e and i vowel words. Beers found that of those children whose spelling did change over time more children followed the sequential patterns outlined in the previous studies on all but one of the exemplars. Furthermore, the first graders showed

more progress over time primarily because second graders were often already using the higher level strategies. Beers suggested that this might be due to a combination of greater classroom experience and a higher level of cognitive development. Overall his research confirmed the findings of the previous studies.

Summary of Spelling Research

It is evident from the above review that research into spelling difficulties has changed radically during the last decade. Earlier researchers were content to list sources of spelling errors without investigating why these words were misspelled or how children's efforts varied from the correct forms. Later on, there were some attempts to categorize errors, but these dealt only with the surface level of language, and therefore were unable to offer adequate explanations. Innovative computerized studies of the orthography were a move in a more fruitful direction, but because they were based on the rather unsophisticated and unidimensional approach of grapheme-phoneme correspondences, they were also unable to provide adequate explanations of the mechanisms underlying orthographic representations.

More recently the works of Weir and Venezky and Chomsky and Halle have shown that spelling is more than a simple match between graphemes and phonemes. The orthography becomes quite understandable and quite regular

when examined in terms of a total language system involving deeper levels of phonological, morphological and syntactic processing. During the last few years researchers like Read, Henderson and Beers, have extended Chomsky's generative, rule-oriented model to closer investigations of children's misspellings. This line of research has produced some significant evidence indicating that children's spelling attempts are not random, but that they seem to follow an orderly sequential progression dependent upon the sophistication of the child's abstract phonological system and his ability to integrate other sources of information into an understanding of English orthography. Thus far such research has been limited to preschoolers and children in the first two school grades. One of the purposes of the present study is to extend the exploration of children's spelling strategies through the first four grades, adding exemplars of later developing patterns of regularity.

Given the highly structured, conceptually complex view of spelling thus far developed, it seems only logical to also investigate the research on the cognitive abilities children develop during that period when they are first expected to make sense of their language's orthography, that is, when they are first expected to read and write. Jean Piaget, the foremost developmental psychologist of this century, has demonstrated conclusively that it is at approximately this time that the structuring of the child's thought undergoes a significant qualitative change. The shift from preoperational to concrete operational thinking

represents a movement from intuitive, perception-bound schemas of reality to more mobile, logico-arithmetic, operatory thought processes.

Thus a second purpose of this investigation is to explore the relationship between a child's spelling strategies and the cognitive structures he is capable of using. The next section of this review will be a brief overview of Piaget's theory followed by a closer examination of those aspects of his model which would seem most likely to apply to the young child's growing understanding of how words work.

Piaget's Theory

Introduction

Piaget's critical question has always been the epistemological one: how is knowledge acquired? More specifically, he has spent considerable time studying what he (Piaget 1967) designates as the two problems which dominate all questions of cognitive development:

> (1) to determine whether knowledge consists only in copying or imitating reality, or whether to understand reality it is necessary to invent the structures which enable us to assimilate reality, and consequently (2) to determine whether the actions performed by the subject on reality consist simply in the construction of appropriate images and adequate language, or whether the subject's actions, and, later, his operations transform reality and modify objects [p. 532].

Piaget is firmly convinced that only the latter alternative to each of the two questions can explain the acquisition of knowledge. The model of this process that he develops is

essentially a biological one. Learning is an adaptive function mirroring the more inclusive biological paradigm of the adjustment of the organism to its environment. Thus the underlying invariant process remains 1) assimilation of the new to the old, 2) accommodation of the old to the new, and 3) the achievement of a balance, or equilibrium between the internal demands of the system and the constraints of external reality.

Thus growth is neither simply a matter of maturation nor one of absorption. It depends upon the interactions of several factors: internal maturation, the action of objects, social transmission and, of course, equilibrium. The first three are, of themselves, insufficient to account for learning since "A whole play of regulation and of compensation is required to result in a coherence [Piaget, 1966 p. 29]." For Piaget a flexible internal regulation, 'progressive equilibration,' coordinates all other factors into an organized system. Learning depends not only on the stimulus, but on the structure or system the learner has available to process it.

The qualitative differences in these available structures, and thus in the way in which the organism is capable of dealing with physical experience, delineate the stages of cognitive development. Piaget (1973) enumerates four major cognitive stages: sensori-motor, pre-operational, concrete operational, and formal operational.

The sensori-motor stage (birth to 18-24 months)

begins with innate reflexes which are coordinated into schemas of action. Eventually these are intercoordinated into goal-directed activities which mark the first signs of intentionality. However, these schemas remain 'practical' in the sense that they are completely concerned with perceptual and motor adjustments. They are also thus limited to the actual space and time necessary for their physical completion.

The preoperational stage (1½-2 years to 7-8 years) is especially marked by the appearance of the semiotic or symbolic function (Piaget 1968), most readily observed in the development of language. The emergence of symbolic representation liberates the child from the immediate, giving him some control over space and time. All elements of an organized structure can now be represented simultaneously. Language provides a contact with others which demands an objectivity uncharacteristic of the previous stage. At the same time, however, the child remains concerned with the immobile, perceptual aspects of configurations. His attention is centered on the states of objects rather than on their transformations. From this limited perspective he sees no need for justification or proof. The state of the object is, in itself, sufficient evidence.

The first two stages of development are constrained by the limitations of intuition and perception. The gradual emergence of concrete operational thinking (7-8 years to

11-12 years) marks the beginnings of a 'logical' system somewhat freed from such constraints. The level of operations is concerned with transformations of reality by means of internalized actions that are grouped into coherent, reversible systems:

> The states are henceforth subordinated to the transformations, and these transformations, being decentered from the action of the subject, become reversible and account for both the changes in their compensated variations and for the constant implied by reversibility [Piaget and Inhelder, 1969 p. 98].

But concrete operations, though liberated from immediate perception, still relate directly to objects and groups of objects. They are bound by their content and limited to observations regarded as true. With a gradual movement to formal operations (11-12 years to adulthood) the child begins to differentiate between form and content, and thus becomes capable of reasoning about hypothetical situations. He is now able to use propositional logic and integrate ideas and hypotheses into a highly sophisticated combinatorial system.

Each of the stages is described in terms of advances over previous development and also in terms of the inherent limitations of its cognitive structure which temporarily prohibits more complex coordinations and therefore more useful generalizations. Piaget often refers to such limitations as centrations and the eventual overcoming of these limitations as decentration. In the sensori-motor stage, for instance, the child 'centers' on motor activity. But, through a succession of coordinations

of actions, he is able to progress to the symbolic representation of preoperational thinking which leads to a decentration away from purely action oriented schemas. The following section will deal specifically with the nature of decentration during that period of growth directly related to this investigation: the development from preoperational to operational thinking.

Preoperations and Operations

As noted above, the preoperational child is bound by, or 'centers' on, the perceptual states of objects. Though he is aware that these objects may be changed from state to state, he is unable to compare them across states without centering on perceptual cues of limited value. An analysis of one of the typical tasks Piaget presents to school age children will clarify and elaborate this stage of centration-decentration. The problem chosen is the classic conservation of continuous quantity (Piaget and Inhelder, 1969).

The child is presented with two glasses of equal size, equally filled with water. The water from one glass is then poured into a thinner, longer container. The preoperational child now typically judges that the thinner container has more water, since the level is higher. He 'centers' on the perceptual states of the water, and considers only one aspect of the problem. He 'centers' on the height. If an extremely thin, elongated container

is introduced, he may even successively vary the relevant dimension. He may now decide that thickness is more important and judge that the shorter, thicker glass contains more water. But he is unable to consider both aspects—higher but thinner vs. shorter but wider—simultaneously in seeking a solution. In Piaget's terms he lacks compensation.

The operational child, on the other hand, may approach the problem from one of two different but equivalent points of view. Having the ability to combine classes (like height and width), he may judge the quantity of the water to be the same by compensating for one dimension in terms of the other. He may, on the other hand, also 'decenter' from the perceptual state and mentally re-enact the transformation involved. Thus he reasons that nothing has been added or taken away, or that the water can be returned to the original container and thus returned to its original height and width. Piaget calls this reversibility. Thus, the preoperational child, centering on a particular aspect or state, uses neither compensation nor reversibility in reaching a solution. The operational child, however, sees these as directly related to the solutions and utilizes one and/or the other in expressing his decision.

One of Piaget's more important discoveries was that these interstage differences follow similar patterns across various tasks and concepts (number, quantity,

classification, time, space, etc.). The discussion will now turn to those concepts which are included in the testing procedures of the current investigation: perception, classification and conservation of number and quantity.

Perception

For Piaget (1966) perception is prelogical and non-reversible, and so cannot be viewed as a particular developmental aspect of the four stage sequence. However, perception does resemble cognitive development in that it demands that the perceiver actively apply an organizing structure to the stimuli. Piaget investigates these structures through the device of the perceptual illusion. For example, a subject is asked to compare the size of two equal lines, one at the point of fixation and one on the periphery. Because he 'centers' on the line at the point of fixation and uses it as the standard for comparison, the subject typically overestimates its size and underestimates the size of the other line. Piaget calls this the 'error of the standard.' He reasons that the fact that this illusion, along with many others (including the illusions of Delboeuf, Oppel, and Müller-Lyer), decreases fairly regularly with age can be attributed to an increase in decentralizations: "Certainly the young child remains passive where older children and adults compare, analyze and thus indulge in an active decentralization which is oriented toward operational reversibility [p. 80]." Therefore,

> The development of perception bears witness to the existence of a perceptual activity leading to decentralizations, transportations (spatial and temporal), comparisons, transpositions, anticipations and, in general, an analysis becoming more and more mobile and making for reversibility. This activity increases with age, and it is because they do not possess it to a sufficient degree that young children perceive in a 'syncretic' or 'global' manner or else by accumulating disconnected details [pp. 84-85].

In a series of studies, David Elkind and his associates (Elkind and Scott, 1962; Elkind and Weiss, 1967; Elkind et al., 1964; Elkind et al., 1970) responded to Piaget's analysis by investigating perceptual development in school age children. They showed their subjects ambiguous figures (for example, a vase made from two profiles) and/or pictures of whole objects whose parts were themselves independent, easily identifiable entities (for example, an airplane made from several different vegetables). Elkind and his associates noted an age-wise increase in children's ability both 1) to perform figure-ground reversals and thus to see both possibilities in ambiguous pictures and 2) to recognize both parts and wholes together on Elkind's Picture Integration Test. Specifically, Elkind argued that part-whole perception requires a shift in focus from part to whole and vice versa, and that the general increase in ability with an increase in age supported a developmental decentering analysis of perceptual activity.

Classification

While Elkind has examined part-whole relationships

as a function of perceptual regulations, Piaget (Piaget, 1966; Piaget and Inhelder, 1969) has concentrated on part-whole relationships as a question of logical classification. In the well-known class inclusion problem the child is presented with a large class of objects, A (for example, plastic poker chips) made up of two sub-classes B and B^1 (for example, red and white chips) with B usually noticeably larger than B^1. When the child agrees that $B>B^1$ (for example, there are more red chips), he is asked to compare A and B (for example, 'Are there more red chips or more plastic chips?'). The younger, preoperational child answers that there are more of the subclass than of the total class, while the operational child recognizes that the whole class is necessarily larger. The preoperational child is unable to respond in terms of the inclusion A>B because he 'centers' on the part, and fails to conserve the whole as a unit, and so compares B to B^1. Piaget therefore argued that the understanding of the relative size of a subset to a set marks the achievement of a genuine operation because it requires 'decentering' away from the parts to the whole and mentally transforming the set into subsets and vice versa. Class inclusion thus serves as a logical analogue to the previously discussed perceptual tasks.

Conservation of Number and Quantity

The principles of decentration, compensation and reversibility are, of course, central to Piaget's most

famous set of problems, the conservation of quantity tasks. The investigator's earlier description of the problem of conservation of continuous quantity [p.30] serves as an adequate illustration of the necessary relationship between these principles and conservation. However, Piaget has argued that the various forms of quantity are not conserved simultaneously. There is a definite progressive order of conservation. There is near universal agreement among Piagetian scholars that number is conserved earliest and marks the beginning of operational thinking. Piaget states that the remainder of the sequence, substance, weight and volume, is also invariant. His argument is that each concept logically implies the conservation of the previous ones. The child begins with substance because "this substance without weight or volume, is not perceptively empirically noticeable; it is a pure concept, but a necessary one in order to continue to arrive at the notion of weight and volume [Piaget, 1973 p. 9]." In regard to this sequence, Almy, Chittenden, and Miller (1966), Elkind (1961), Goldschmid and Bentler (1968), and Sigel and Hooper (1968) and many others have confirmed its general validity, but remain somewhat equivocal about its absolute invariance.

The seemingly progressive, developmental nature of the conservation of quantity sequence suggests that problems of decentration vary in complexity, so that later appearing conservations, like volume, necessarily involve

more sophisticated coordinations, since the number of variables to be held constant, and thus the number of dimensions to be considered, are increased. (In terms of the present investigation it is possible that concepts of word knowledge are related to particular levels of decentration rather than to a simple preoperation-operation difference.)

Summary of Piaget

In general, Piaget's model is based on the interaction between organism and environment. In such a model it is essential that the organism actively invent structures and apply them to experience in order to comprehend it. The types of structures available mark the difference between developmental stages.

In particular, in the preoperational stage the child's structures are limited to the static condition of objects so that he 'centers' on a particular immediately available perceptual cue. In the operational stage, on the other hand, the child develops more general, coordinated structures permitting him to consider transformations of objects as operations which relate previous states to present ones. He is thus able to move away from isolated consideration of static perceptual information.

More specifically, the differences between these two stages can be observed in the child's attempts to deal with problems of perceptual and logical part-whole relationships and with the several levels of the problem of

conservation of number and quantity. In these examples the preoperational child fails to consider transformational relationships which the operational child views as essential to the proper solution of the problems.

Some Reactions to Piaget

Given the extremely broad scope of the Piagetian model, and the abundance of exciting, inventive research problems the theory has generated, it would be surprising, indeed, to discover complete agreement among Piagetian scholars. Some major questions of interpretation have been raised.

Bruner et al. (1966), for example, have argued that reversibility and compensation are not sufficient for conservation. What is essential is, rather, an underlying primitive notion of identity. Simultaneously, they have suggested that the encoding of judgments (that is, proper syntactic form in verbal expression) prior to visual interaction with the changing stimuli facilitates conservation. Piaget (1967) and Sinclair-de-Zwart (1969) have argued strongly against these assertions, maintaining that operations direct language-acquisition, and not vice versa.

In a more recent development, Flavell (1971) has questioned strict interpretations of the Piagetian notion of developmental stages. Reacting to the rather equivocal evidence on the simultaneity of development across concepts (like quantity, time, number, etc.—see Sigel

and Hooper, 1968), he has suggested a much more flexible notion of "stage" in which 1) quantitative changes (like increased short term memory) may make qualitative changes possible, and 2) differences in 'competence' and 'performance' may lead to observable behavior that varies widely, even going across several stages, depending upon the content of the task at hand. Flavell does point out, however, that Piaget's theory itself does not logically require anything but a very loose item concurrence. However, other Piaget-like research attempts have been misguided in rationale.

These two examples of varying interpretations of Piagetian notions serve as reminders that, like any other broad-based, comprehensive theory, Piaget's model does not solve all the problems nor answer all the questions of cognitive development. It must be interpreted and revised as new information in response to old as well as new questions demands. On the other hand, most of the evidence to date (Sigel and Hooper, 1968) has confirmed many of Piaget's hypotheses. The framework of the structure remains strong. Most importantly, in terms of the present study Piaget's theory suggests a way of viewing the relationship between cognitive development and word knowledge that merits further exploration.

Decentration and Reading

Though the relationship between cognitive development and conceptual understanding of words has not received

the attention it deserves, several investigations have attempted to deal with the broader problem of the relationship between conservation and reading achievement.

Almy et al. (1966) found a high positive correlation between conservation and reading achievement scores among middle class subjects. Among more heterogeneous samples, Brekke, Williams, and Harlow (1973) and Lepper (1966) reported low but significant positive correlations between conservation of number and substance and performance on standardized reading readiness measures among first graders. Heatherly (1971) also reported a significant correlation between conservation attainment, vocabulary and comprehension scores, and hypotheses testing, even when the effects of mental and chronological age and socioeconomic status were partialled out. Briggs and Elkind (1973) and Huria (1972) examined separate groups of good and poor readers. Both studies found a significant difference favoring good readers in performance on Concept Assessment Kit—Conservation (Goldschmid & Bentler, 1968) (a standardized conservation measure).

A few studies have approached the problem from a more complex theoretical base and have attempted to examine more specific aspects of the relationship. David Elkind and his associates have expanded upon the perceptual centration studies previously cited (see above, p. 33) by investigating the relationship between decentration and word recognition and overall reading achievement. They

reasoned that in order to be a proficient reader one must be able to deal with the fact that individual letters or groups of letters can have more than a single pronunciation, depending upon their context. Such an ability seems to imply a more general ability to move away from a single perceptual cue and to consider environmental factors. In a series of studies (Elkind, Horn and Schneider, 1965; Elkind, Larson and Van Doorniuck, 1965; and Elkind and Deblinger, 1969) Elkind and his associates found a consistent significant relationship between decentration and reading performance. Furthermore, they also reported some reading achievement gains by an experimental group trained in a variety of nonverbal perceptual decentration activities.

McGinitie (1973) also has argued that young children are not necessarily ready to analyze and synthesize language in terms of adult-created rule systems. He has suggested that this inability may be related to Piaget's notions of preoperational egocentrism and nominal realism. McGinitie developed a series of logical tasks (done with concrete objects like blocks) analogous to some of the rules children are often asked to master during initial reading instruction. He found that children were often unable to begin to understand the demands of such tasks. He thus warned that, though the preoperational child generates complex syntactic utterances, teachers cannot assume that he can analyze and synthesize these as individual examples

of structural principles.

Unfortunately, almost all of preceding investigations, while concentrating on the Piagetian tasks involved, have utilized instruments which provide only the grossest kinds of estimates of reading achievement and, therefore, conceptual word knowledge. A wide variety of factors are involved in success on these measures, and, in general, there is a lack of any theoretical linguistic justification for their quantified results. Thus, studies in which they have been used have provided only the most general kinds of information regarding the relationship between cognitive development and a truly conceptual understanding of the way the English writing system works. In the present study an attempt has been made to remedy this situation in two ways: 1) by providing a task (attempting to spell low frequency words) aimed more specifically at a conceptual level of understanding, and 2) by looking beyond the correctness or incorrectness of the response to the manner in which the child approaches a word's spelling. It is hoped that such an approach will provide more specific information about the relationship between development and the conceptual aspects of word knowledge.

General Summary

This discussion has been concerned with two distinct areas of inquiry, recent theoretical and experimental investigations of the English orthographic system and

Piaget's theory of cognitive development. Though these areas may have initially seemed quite different, a close investigation has revealed a common theme: the need for the learner to invent (in Piaget's words) or generate (in Chomsky's terms) coordinated structures or systems in order to understand reality. The theoretical investigations of Venezky and Chomsky have demonstrated that English orthography is, in fact, quite regular when several levels of processing are taken into account indicating that it can be most efficiently processed in terms of a model based on the coordination of several levels of structure. Piaget's interactive theory provides a more general epistemological context into which Chomsky's linguistic model can comfortably be placed. Piaget's emphasis on the processes of assimilation, accommodation and equilibration also provides a framework for the creation and coordination of structures.

Furthermore, it is this investigator's belief that Piaget's notion of qualitative stages of cognitive development may provide a key to understanding the progressive sequential spelling strategies discovered and substantiated by Read, Henderson and Beers. It seems plausible, in terms of the above theories, that a child's spelling strategies will be dependent upon his ability to generate and coordinate abstract structures for dealing with language. Piaget's distinction between preoperational and operational modes of thinking seems especially relevant to the primary

grade child's approach to the way words are spelled. For example, the preoperational child's centering on perceptual cues should dictate a fairly consistent letter-name strategy, while the operational child should be able to use more sophisticated patterns like orthographic marking, etc.

Two cautions must be noted, however. This discussion has centered specifically on the conceptual or structural aspects of development and of word knowledge. But the theories involved are interactive, that is, they recognize that the environment as well as invented structures are essential to the acquisition of further knowledge. Indeed, structures can only be generated through and tested against feedback provided by experience. Consequently, exposure to and familiarity with written language will also have an effect upon the conceptual strategies used. The present study has tried to minimize this factor by selecting children from approximately the same educational background, and by providing a spelling task that involves words that appear in print at a relatively low frequency.

Second, if one accepts the notion that word knowledge has a conceptual basis and is, therefore, a cognitive task, it follows that dealing with written language may very well provide the experience that may lead to the development of more complex cognitive structures. Thus no assumptions have been made about a simple cause-effect relationship between success on Piagetian tasks and more advanced spelling

strategies. However, it would be very surprising to find no significant correlation between success on these two kinds of cognitive activities. It is precisely this correlation which is being examined in the present study.

CHAPTER III

PROCEDURE

Sample

Fifteen pupils from each of the first four grades of Sycamore Park Elementary School, Culpeper, Virginia, were the subjects for this study. Initially, one class from each grade level was randomly selected for participation. Then two spelling lists were administered to each whole class selected. The resulting spelling attempts were briefly examined by the investigator in order to exclude those pupils who 1) made no attempt to spell the words, 2) put down only single letters for words, or 3) had simply strung random letters across the page. This guaranteed that the subjects knew what letters were, knew what a written word was, and knew how to write. Next, of those pupils who remained 15 from each class were randomly selected. On the following day a decentration instrument, specially constructed for the purposes of this study, was administered to these final 60 pupils.

The children in this sample were from a mixture of socio-economic backgrounds. Sycamore Park Elementary School draws its student population from both an in-town, middle class population and a local rural element, as well as from a group of semi-permanent civilian families

whose head of household is employed by the armed services. This mixture made for fairly wide diversity in cultural and educational backgrounds.

Sycamore Park Elementary School allows its teachers considerable flexibility in constructing their reading-language arts programs. Each of the four teachers whose pupils were the subjects of this investigation indicated that they used a wide variety of materials and techniques in meeting the needs of their students, including language experience as well as basal reader approaches to instruction. In general, spelling instruction was integrated into the overall reading program, and spelling drill work was considered only a minor part of a student's reading-language arts activities. Given the flexibility of the teachers and their rather similar philosophies, it was decided that the classroom variable could be ignored in this study.

Spelling Categories

Five major spelling categories were selected for examination in this investigation. Each of these categories was, in turn, divided into more specific subcategories. These were:

1. Lax vowel spellings
    a) Lax <u>a</u> as in <u>cat</u>.
    b) Lax <u>e</u> as in m<u>e</u>t.
    c) Lax <u>i</u> as in <u>sit</u>.

2. Tense vowel spellings

a) Tense a as in take.

b) Tense e as in creep or thief.

c) Tense i as in slime.

3. Past tense morphological markers

a) ed pronounced /t/ as in raked.

b) ed pronounced /d/ as in trimmed.

c) ed pronounced /Id/ as in cheated.

4. Consonant doubling patterns before inflectional endings

a) Following lax vowels as in flopped (p doubled).

b) Following tense vowels as in wading (no doubling).

5. Patterns of extending the spelling of an accented tense vowel in a word to the spelling of the unaccented 'schwa' in a word with the same 'root.'

a) Tense a as in inflame, paired with schwa a in inflammation.

b) Tense e as in compete, paired with schwa e in competition.

c) Tense i, as in inspire, paired with schwa i in inspiration.

Spelling Word Lists

Two single-syllable, low frequency words were selected for each of the six vowel subcategories. Two double-syllable (single syllable word plus marker) low

frequency words were chosen for each of the three Morphological Marker subcategories. Three double syllable (single syllable word plus inflectional ending) words were selected for each of the two Doubling pattern subcategories.

For the Vowel Extension subcategories a slightly different procedure was used. Two pairs of words, rather than single words, were chosen for each subcategory. No restrictions were put on the frequency of the first word, though an effort was made to use high frequency examples of vowels in the accented syllable. On the other hand, an attempt was made to use low frequency examples of the vowels in the unaccented syllables. (The reason for this will become clear when the rating systems are explained.)

Frequency ratings were determined from Thorndike and Lorge's The Teacher's Word Book of 30,000 Words (1944). Except for the first words in the Vowel Extension pairs, only one word (dining) had a root word (dine) that occurred more than 50 times per million words in the overall list. Skid was the lowest frequency single syllable word (3 occurrences per million), while inflammation had the lowest overall frequency, occurring only twice per million words.

An effort was also made to provide balanced representatives of vowel environments (such as nasal, plosive, or fricative following consonants or consonant clusters) in order to avoid biasing the data toward particular vowel environments. In the first six subcategories, no pair of

exemplars contained two words with the same vowel environment. On the other hand, since specific vowel-phoneme relationships were not of primary concern in the other three categories, more freedom was used in selecting exemplars.

Since it was decided that 36 words were too many for the younger children to spell at one time, two lists were devised with one exemplar from each subcategory randomly selected for each list. The lists were then randomly ordered except for the Vowel Extension pairs. These were arranged so that the word with the vowel in the accented syllable preceded the word with the vowel in the unaccented syllable. Furthermore, only one word separated the two members of a pair.

Each word to be spelled was first pronounced, then used in a sentence, and pronounced again. The sentences were constructed so that each exemplar received enough stress so that the phonetic rendering of the word would be distinct and clearly heard. Furthermore, the semantic information in the sentence was constructed so that it added to the child's understanding of the word. For instance, past tense words were consistently accompanied by adverbs (for example, yesterday) or some other referrent, which made the tense of the exemplar quite clear in addition to the tester's pronunciation of the word at hand. In the case of Vowel Extension pairs, an effort was made to keep the subject matter as similar as possible

across sentences in order to facilitate the pupil's realization that both words were similar in meaning. The following excerpt from one of the lists illustrates these points:

3.	bragged	Yesterday John bragged about his shiny new bike.
4.	compete	Willie liked to compete in all games.
5.	spike	Jack tore his pants on a spike while climbing a fence.
6.	competition	Willie wanted to win the game, but he had lots of competition.

(The spelling lists can be found in Appendix A.)

Spelling Test Administration

On May 19, 1975, the two lists of words were administered to all four classes by two testers. The first list was administered in the morning and the second in the afternoon. Each administration took approximately 30 minutes. Each child was given a sheet of paper and instructed to put his name and grade on it and to number down the page 1 to 18. When all the children were ready, the following instructions were given.

> I want to find out some things about how school children spell words, and I would like you to help. I am going to say some words that I want you to try to spell. First I will say the word, then I will use it in a sentence, and then I will say it again. Then I want you to spell the word. Do the best you can, even if you are not sure how the word is spelled. This is not a test, and you will not receive a grade, but it is very important to try your best. Now here is the first word.

The test administrators encouraged the children to

make attempts by suggesting that the reluctant child listen to the sound of the word and then decide what letters belonged. If there were any requests for it, the word and sentence were repeated. However, no further cues or strategies were suggested.

Scoring Criteria

Findings of previous studies (Beers, 1974; Henderson and Beers, 1974; Read, 1971) indicated a sequential pattern moving from strictly direct phonetic representations, through attempts that suggest logical, though often imperfect, adjustments to coordinated systems which lead to the production of the correct form. The scoring scale used in this study was developed from the one used by Beers (1974). Two scoring levels have been added, a 0 rating for unclassifiable attempts and a 5 rating to help distinguish between correctly formed elements under investigation in an incorrectly spelled word (4) and correctly spelled words (5). The scale has also been extended to the three new spelling categories developed for this study.

Beers' findings indicated that the scale did in fact differentiate progressively more sophisticated spelling strategies. In view of his results the scores derived from the application of the scale used in this study will be treated as continuous in the subsequent data analyses. The progression is illustrated in the

following scoring criteria and examples:

Category	Strategy	Score	Examples
Lax Vowel	unclassifiable	0	krof (craft), scod (skid)
	vowel omitted	1	krft, scd
	closest tense vowel	2	crift, sced
	transitional	3	creft, scad
	vowel correct, incorrect form	4	kraf, scid
	correct form	5	craft, skid
Tense Vowel	unclassifiable	0	crop (creep), slom (slime)
	letter-name	1	crep, slim
	transitional	2	crip, slam
	vowel correct, marking incorrect	3	creyp, sliym
	vowel correctly marked, incorrect form	4	creap, sime
	correct form	5	creep, slime
Tense Marker	unclassifiable	0	rake (raked), cet (cheated)
	letter-name	1	rakt, chetd
	d-marker	2	rakd, cheatd
	vowel (not e, not o) + d	3	racid, cheatud
	marker correct, incorrect form	4	raced, cheeted
	correct form	5	raked, cheated
Consonant Doubling	unclassifiable	0	flop (flopped), wad (wading)
	letter-name	1	flpt, wadn

Category	Strategy	Score	Examples
Consonant Doubling	lax, undoubled	2	floped
	tense, doubled	3	wadding
	doubling correct, incorrect form	4	floppid, weding
	correct form	5	flopped, wading
Vowel Extension	unclassifiable	0	xpln-xplntn (explain-explanation)
	letter-name	1	xplan-xplnashon
	vowel present, unextended	2	explain-explinashon
	vowel incorrectly extended	3	explain-explaination
	vowel correctly extended, incorrect form	4	explain-xplanashon
	correct form	5	explain-explanation

In general, ratings of 0, 1, 4 and 5 were based on the same criteria across all five categories. A 0 rating indicated that the attempt could not be classified in terms of any of the strategies being considered. A 1 rating suggested a basic letter-name strategy. (In the lax vowels, however, this took the form of vowel omission, since lax vowel sounds are not as obviously related to the names of the vowels.) A rating of 4 indicated that that particular aspect of the word under examination was handled correctly, but that the word was somehow misspelled. A 5 rating simply indicated a correctly spelled word.

Ratings of 2 and 3, on the other hand, varied

slightly in meaning from category to category depending upon the particular demands of the type of word under investigation. For example, for Consonant Doubling a 2 rating indicated a more sophisticated concept of a word than simply letter-name correspondence, but also an unawareness of the doubling principle (this can only be observed in lax vowel monosyllabic words with an added inflectional ending). A rating of 3 (only possible with tense vowels) suggested an overextension of the rule to cases where consonants are not to be doubled.

On the other hand, for Vowel Extension a 2 rating indicated recognition of the need for a vowel in the unstressed syllable, but a lack of awareness of the principle that the vowel should be the same across words with similar meanings, even though the sounds are not phonetically the same. A 3 rating suggested some awareness of this principle, but an imperfect understanding of how it is incorporated into the overall spelling of the word. Thus, though these ratings had slightly different meanings across categories, they did represent parallel developments in the sophistication of the strategies used.

Two raters independently scored each of the spelling word responses of each subject for each of the two spelling lists. The resulting inter-rater reliability coefficients for each word ranged from .93 to 1.00. For purposes of analysis the ratings of the two raters were then added together to arrive at a total score for each subject on each word.

Decentration Tasks

For the purpose of this study, a battery of tasks that measured a child's ability to decenter was assembled and administered to the 60 subjects previously selected. This battery consisted of five conservation tasks (one each for number, continuous quantity, mass, weight and volume), two class inclusion tasks, and David Elkind's Picture Integration Test (in press). (The complete battery, including testing and scoring procedures, can be found in Appendix B.) The conservation of substance tasks (mass, weight and volume) were all done with the same physical material (playdoh), so the conservation and class inclusion tasks were purposely ordered to avoid two consecutive tasks being done with the same material. The order of the tasks was: mass (playdoh), number (colored poker chips), continuous quantity (water), weight (playdoh), class inclusion (paper geometrical shapes), volume (playdoh and water), and class inclusion (colored poker chips). Following the completion of these tasks, the Picture Integration Test was administered as a single unit. The order of the administration of this battery remained the same for all subjects.

Conservation and Class Inclusion Tasks

On the whole, the procedure for the conservation and class inclusion tasks followed the classical Piagetian model (see above p.30, p.34, and Appendix B). There was one variation on the conservation tasks, however. After

the child agreed that the two objects (or set of objects) were equal, one object (or set) was placed behind a screen. Then the object (or set) in front of the child was transformed. The child was then asked to make an identity judgment—one dealing with the same object (or set) over two states, past and present. The other object (or set) was then returned to view with care taken to assure the child that he was not being tricked, and that the object (or set) had not been manipulated in any way. The child was now required to make an equivalence judgment—dealing with the present states of the transformed and untransformed objects (or sets). After the child's performance on each of the tasks of the whole battery had been scored, the scores on his identity and equivalence judgments on each task were added together to determine his conservation score for that task.

The procedures for the two class inclusion tasks were identical to each other. The only difference was in the materials used. On the first task the child was asked to compare the subclass of particular geometric paper shapes (triangles or squares) to the larger class of paper shapes. On the second task the subclass was colored plastic poker chips (blue or red or white) and the larger class was simply plastic poker chips. Each child was given one class inclusion score, the sum of his scores on these two tasks.

The scoring of a child's performance on these tasks

was based on Piaget's clinical method. The testers recorded the child's reasoning behind each judgment as well as the correctness of each response. If the child's reasons were unclear, the tester was required to question further to determine how the child arrived at his decision. The child's judgment received a 'yes' rating when he judged the object (or set of objects) to be the same in both states (identity) or when he judged the transformed and untransformed objects to be the same (equivalence). His reasoning received a 'yes' rating if it was based on logical principles like reversibility and compensation rather than on a particular perceptual cue. (See above p. 31.) Any confusion or lack of certainty on the part of the child was duly noted by the tester, and as much of his response as possible was recorded on the scoring sheet. Each child was then given a score of 1, 2 or 3 on each judgment he was required to make. A 1 indicated no conservation. A 2 indicated a transitional stage in which the child was uncertain or confused about his response and often vascillated between a conservation and nonconservation judgment. A 3 was given for a correct response accompanied by logical, rather than perceptual, reasoning.

Picture Integration Test

In this part of the battery each child was shown seven pictures, one at a time, and asked to describe what he saw. Each picture was made up of several separate,

identifiable objects which together formed another unrelated, easily identifiable figure (for example, several vegetables which formed a plane, see Appendix B). If the child described only the whole or only the parts, he was asked 'Anything else?' Following this question only responses that needed clarification were questioned, and only spontaneous answers were recorded.

According to Elkind's scoring system, a child should be given a score of 1 if he describes only the parts, a 2 if he describes only the whole, and a 3 if he describes both the parts and the whole, for a maximum total score of 21 for the seven pictures. The scoring sheet used for this study contained a slight modification in the scoring procedure. The tester was also asked to distinguish between a sequential recognition of parts and the whole (scored 3) and a simultaneous recognition of both (scored 4). However, though the scoring sheet indicates this distinction, it was decided that, for the purpose of this investigation, Elkind's scoring system would be used.

Decentration Task Administration

On May 20, 1975, five previously trained testers administered the decentration battery to 58 subjects, testing approximately 12 subjects each. Because of absences, 2 subjects had to be tested on the following day. The subjects were randomly assigned to the testers

with each tester assigned approximately the same number of subjects from each grade. The testing was done at five separate tables set up in a large private room. After introducing himself to the child, the tester proceeded with the battery, assuring the subject that he would not receive a grade for his performance, but encouraging him to answer as well and as honestly as he could. Each administration took approximately 30 minutes.

Design and Analysis

Each child was rated on a total of 37 items, 30 spelling attempts and 7 decentration tasks. Each spelling score had a possible range of 0 to 10, based on the sum of the scorings of the two raters. Each of the 5 conservation scores had a possible range of 2 to 6, based on the sum of identity and equivalence response ratings. The class inclusion score also had a possible range of 2 to 6, based on the sum of the two class inclusion response ratings. Finally, Picture Integration Test (Elkind, in press) scores could range from 7 to 21.

The spelling data were subjected to a two-way, subject (60) x item (30) analysis of variance with items as repeated measures across subjects (Meyers, 1966). The variance for subjects was partitioned into two parts, variance for subjects (15) within grades (4) and variance for subjects between grades. The variance for items was subdivided three times into categories (5), subcategories

within categories (3, 3, 3, 2, 3), and exemplars within subcategories (2, 2, 2, 3, 2), so that there were 6 exemplars for each category. In this analysis grade, category, and subcategory were considered fixed variables, and subject and spelling items were considered random. Because of programming limitations a separate analysis was done for each category (5) along with an analysis for spelling items (30). These 6 analyses were then pieced together to yield the final analysis of variance found in the following chapter. It was believed that such an analysis would indicate whether there were significant main effects for grade and category. The interaction between these two variables was also examined.

Next, the 6 exemplar scores for each subject for each category were added together. A canonical correlation analysis (Cooley and Lohnes, 1962) was performed on the 5 spelling category scores and the 7 decentration scores to determine if the two sets of variables were significantly related. Two R factor analyses with oblique rotations (Harmon, 1971) were then performed on all the scores for the 12 variables. The first was conducted on the intercorrelations among the 12 variables, while the second was conducted on the partial correlations generated when the effects of grade level were controlled. It was believed that these analyses would yield descriptive data about the relationship between the two sets of variables.

CHAPTER IV

RESULTS

This chapter is comprised of three sections. The first section presents the findings of the analysis of variance performed on the 30 spelling scores of the 60 subjects. The second presents the findings of the canonical correlation and two factor analyses performed on the subjects' scores on the seven decentration tasks and their total scores for each of the five spelling categories. A final section presents a brief summary of findings in the first two sections.

Spelling Categories

The findings of the analysis of variance are shown in Table 1. They indicate a main effect for grade, category and exemplar. Significant grade by category, category by subjects within grades, and grade by sub-category interactions were also found.

Insert Table 1 about here

The first hypothesis, that there would be mean differences among the grades over all the categories together, was tested by comparing the mean square for grade (A) with the mean square for subjects within grades

TABLE 1

TWO WAY HIERARCHICALLY PARTITIONED ANALYSIS OF VARIANCE OF SPELLING SCORES

Source	df	SS	MS	F
Grade (A)	3	8,233.01	2,744.34	39.51**
S(A)	56	3,889.88	69.46	
Category (B)	4	3,827.36	956.84	14.42**
Subcategory (C)	9	500.78	55.64	.98
Exemplar (D)	16	907.66	56.73	10.06**
AB	12	627.65	52.30	5.23**
BS(A)	224	2,238.92	10.00	1.77**
AC	27	240.79	8.92	1.58*
CS(A)	504	2,773.27	5.50	.96
AD (pooled)	48	281.47	5.86	1.03
DS(A)	896	5,115.53	5.71	
Pooled Residual	1,448	8,170.27	5.64	
Total	1,799	28,636.32		

*$p<.05$.
**$p<.01$.

(S(A)). The results were significant ($p<.01$). An examination of the sum of the means across categories for each grade (see the last column of Table 2) showed a general increase as grade level increased, except for A_2, which was unexpectedly slightly less than A_1. The difference between A_1 and A_3 (17.63) was much larger than the differences between A_1 and A_2 (.35) or between A_3 and A_4 (6.22). This suggested a sharp break between the two lower grades and the two higher grades.

Insert Table 2 about here

The second hypothesis, that there would be mean differences among the categories over all the grades together, was tested by using the Quasi F Ratio procedure outlined by Winer (1962). The mean square for category (B) plus the residual mean square was compared to the mean square for exemplar (D) plus the mean square for BS(A). The result was significant ($p<.01$). An examination of the sum of the means across grades for each category revealed that scores decreased as the levels of the categories increased (see the last row of Table 2). However, the decrease happened in a step-wise, rather than linear fashion. The difference between B_2 and B_3 (4.83) was much larger than the difference between either B_1 and B_2 (2.52) or between B_3 and B_4 (1.80). Similarly, the difference between B_4 and B_5 (6.67) was

TABLE 2

MEAN SPELLING SCORES FOR GRADE (A) X CATEGORY (B)

	B_1 Lax Vowel	B_2 Tense Vowel	B_3 Mark-er	B_4 Doub-ling	B_5 Vowel Ext.	Total
A_1 Grade 1	5.77	4.00	1.80	2.58	1.47	15.62
A_2 Grade 2	4.68	4.58	2.48	2.49	1.04	15.27
A_3 Grade 3	8.22	7.68	7.73	6.43	3.19	33.25
A_4 Grade 4	9.22	9.11	8.53	7.24	5.37	39.47
Total	27.89	25.37	20.54	18.74	11.07	103.61

much larger than the difference between B_3 and B_4 (1.80).

The third hypothesis, that there would be an interaction between grade and category, was tested by comparing the mean square for the interaction (AB) with the mean square for the interaction between categories and subjects within grades (BS(A)). This result was also significant ($p<.01$). A closer analysis of this interaction can be found in Table 2 and Figures 1 and 2.

Insert Figure 1 about here

Figure 1 shows the plots of each spelling category against the four grade levels. In general these confirmed the relationship discovered by examining the main effects for grade, especially the break between the two lower grade and two upper grade levels. B_3 (Marker) showed the sharpest difference between these two groups. B_5 (Vowel Extension), however, did show a more linear growth pattern between A_3 and A_4. In fact A_4-A_3 (2.18) was greater than A_3-A_1 (1.72). Thus B_5, the most difficult category, also discriminated most strongly between A_3 and A_4.

Insert Figure 2 about here

Figure 2 shows the pattern of response for each grade plotted against the five spelling categories. Though each curve shows a general decrease with increasing category level, these varied somewhat for each grade.

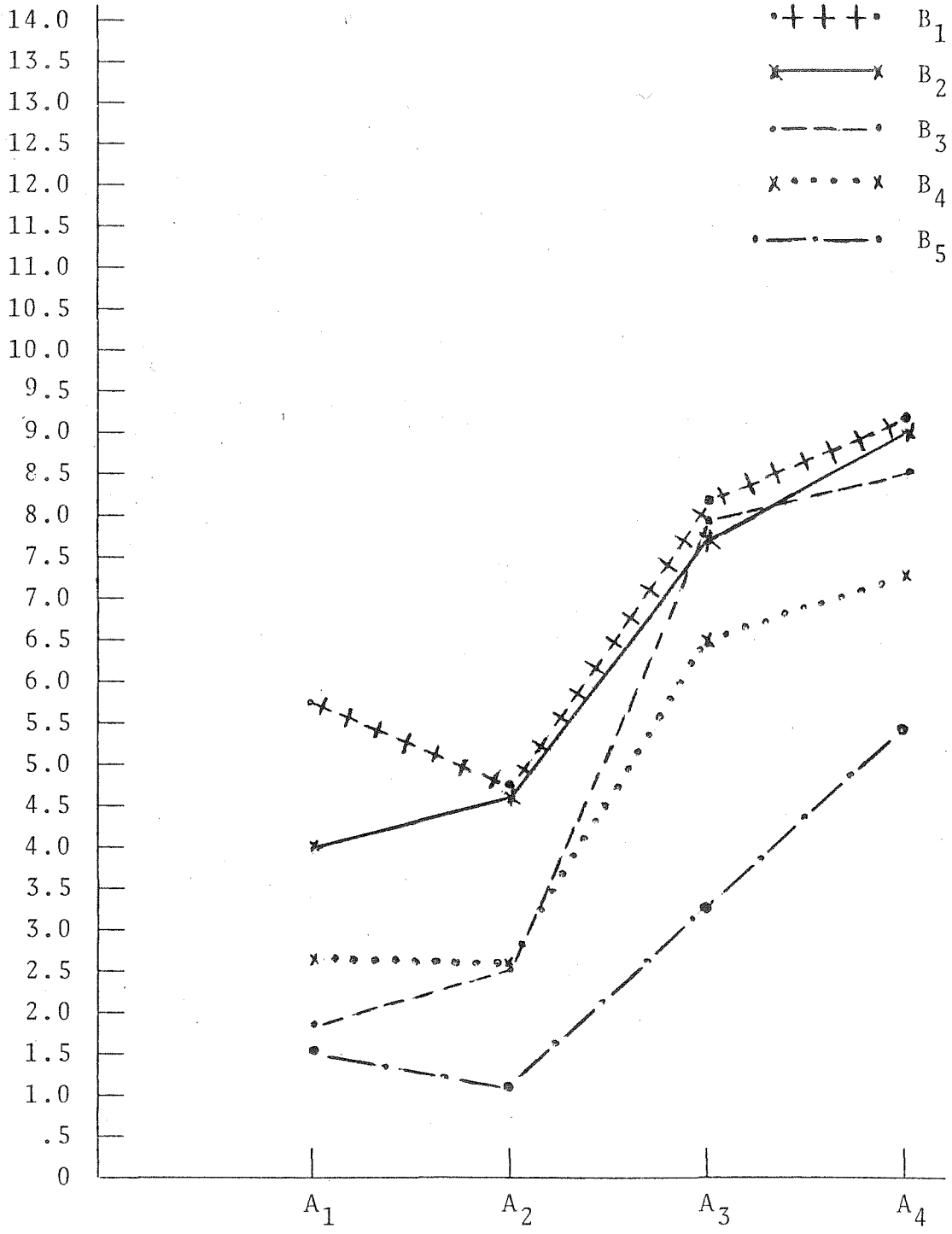


Fig. 1. Graph of mean spelling scores, Category (B) plotted against Grade (A).

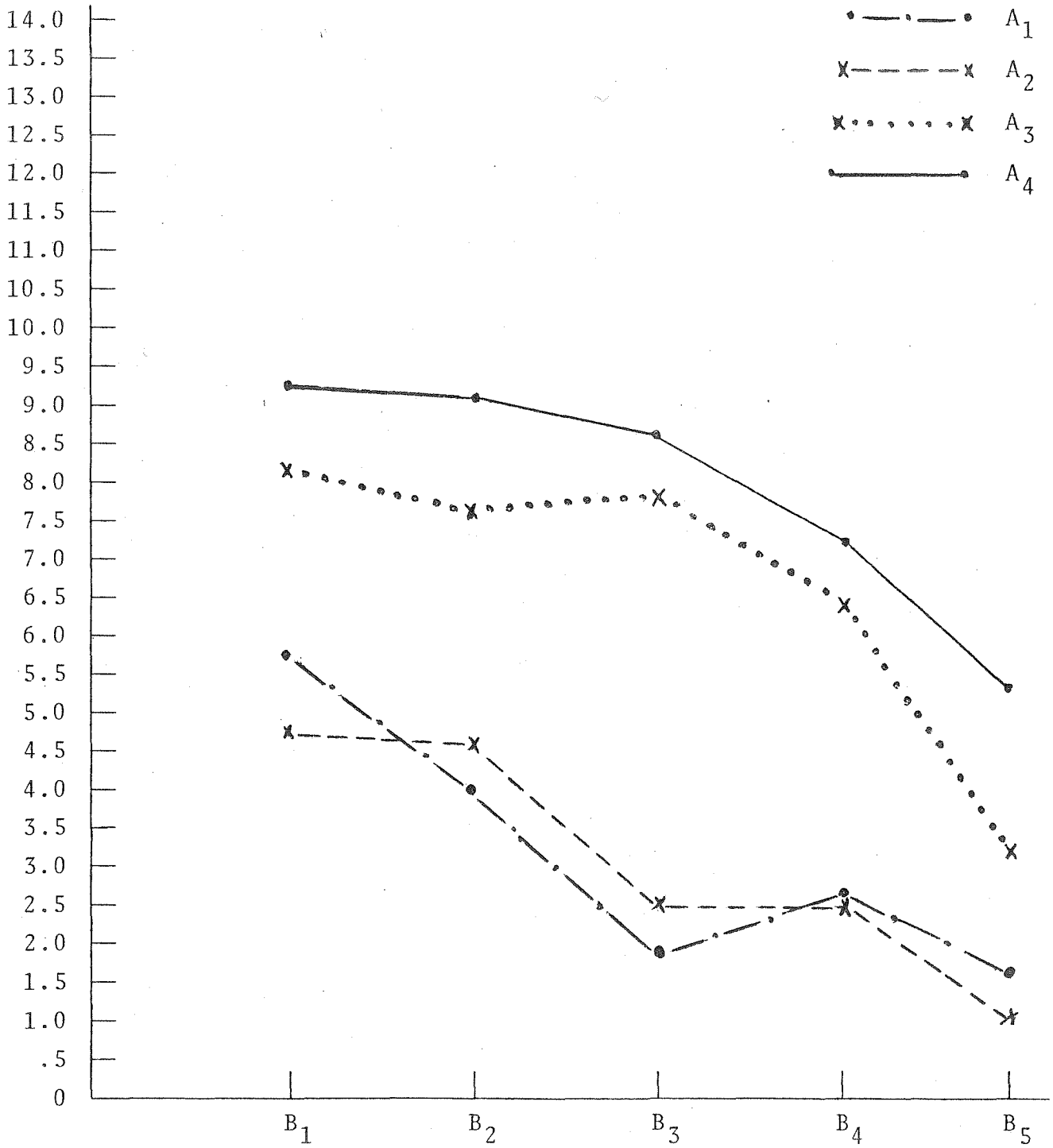


Fig. 2. Graph of mean spelling scores, Grade (A) plotted against Category (B).

Again, however, the difference in patterns for the two lower grades and the two higher grades is evident. For A_3 and A_4, categories B_1, B_2 and B_3 were all relatively easy, so there was little difference between these categories within each of these two grades. B_4 and B_5, however, were progressively more difficult, especially for A_3. For A_1 and A_2, B_3, B_4 and B_5 were particularly difficult, so there was little difference between B_3 and B_4 within each grade. B_5 was slightly more difficult than B_3 and B_4, however.

Though the remaining significant results in Table 1 were not of primary concern in this study, they do deserve some attention. Although it is unconventional to elaborate results in Chapter IV, these findings will be presented and discussed at this time so that their further treatment in Chapter V may be omitted.

The finding of a significant main effect for exemplar (D) was not surprising since a child's knowledge of any particular word may depend upon a wide variety of idiosyncratic factors not controlled in this study. A significant interaction between categories and subjects within categories (BS(A)) was also unsurprising since it indicated that subjects were ranked differently for different categories. This supported the idea that the separate categories did measure different aspects of spelling strategies.

Finally, an examination of the grade by subcategory

interaction (AC) revealed that the statistical significance of the interaction was limited to two categories, B_1 and B_5. In B_1 the a subcategory was the easiest across all grades, while the e subcategory was the most difficult for A_1, A_3 and A_4. These differences were most pronounced for the two middle range scoring grades (A_2 and A_3) and only slight for the grades at the lower and higher ends of the scale (A_2 and A_4) (see Table 2 and Figure 1). This result concurred with Beers (1974) finding that the lax a, e, and i vowels were handled somewhat differently. The variation in B_5 was due almost exclusively to the difficulty of the e subcategory at A_4. Part of the difficulty of this subcategory might have been due to the fact that the e exemplars were the only ones followed by a lax vowel in the following syllable of the second word of the pair. Note the contrast between combination and repetition. This justaposition of schwa and lax vowels in succeeding syllables may have caused some confusion for the subjects.

Decentration Tasks and Spelling Categories

The canonical correlation resulted in a correlation coefficient of .67 between the two sets of variables. This correlation was significant at the .01 level. No higher order correlations were significant.

Tables 3 and 4 show the results of the first factor analysis.

Insert Table 3 about here

Table 3 clearly indicates that there were two separate factors. The decentration tasks loaded very highly on Factor 1, while the spelling categories did not load on this factor at all. The reverse pattern was true for Factor 2. However, the two factors were significantly correlated with each other ($r = .56$, $p<.01$).

Insert Table 4 about here

The intercorrelation of all 13 variables is presented in Table 4. All of the 66 possible intercorrelations were significant, 59 at the .01 level. The intercorrelations within the two sets of variables, in general, were higher than the intercorrelations across the two sets, the spelling categories being more highly intercorrelated than the decentration tasks. Across the two sets of variables, Continuous Quantity was the decentration task most highly correlated with the spelling categories, though Mass and Weight were also highly correlated. In the other direction, the Lax Vowel spelling category was highly correlated with the decentration tasks, especially with Mass, Weight, and Continuous Quantity.

The .43 correlation between the Picture Integration Test and Vowel Extension is particularly interesting. Both

TABLE 3

OBLIQUE FACTOR PATTERN MATRIX FOR DECENTRATION AND SPELLING VARIABLES[a]

Variable	Factor 1	Factor 2
Number	.66	.01
Mass	.78	.03
Cont. Quant.	.84	.03
Weight	.82	.01
Volume	.67	-.03
Class Incl.	.71	-.04
P.I.T.	.62	.04
Lax Vowel	.11	.85
Tense Vowel	-.06	.92
Marker	.01	.92
Doubling	-.02	.96
Vowel Ext.	.01	.87

[a]Correlation of Factor 1 with Factor 2 = .56 ($p<.01$).

TABLE 4

INTERCORRELATIONS OF DECENTRATION AND SPELLING VARIABLES

1.	Number											
2.	Mass	.30**										
3.	Cont. Quant.	.61**	.61**									
4.	Weight	.53**	.62**	.75**								
5.	Volume	.33**	.50**	.43**	.51**							
6.	Class Incl.	.37**	.50**	.48**	.37**	.32**						
7.	P.I.T.	.28*	.48**	.50**	.33**	.29*	.51**					
8.	Lax Vowel	.41**	.54**	.54**	.54**	.27*	.29*	.39**				
9.	Tense Vowel	.42**	.33**	.44**	.34**	.33**	.29*	.23*	.78**			
10.	Marker	.35**	.40**	.47**	.45**	.35**	.38**	.35**	.78**	.80**		
11.	Doubling	.31**	.44**	.45**	.45**	.32**	.35**	.37**	.85**	.78**	.86**	
12.	Vowel Ext.	.25*	.42**	.43**	.38**	.33**	.35**	.43**	.73**	.67**	.77**	.82**
		1	2	3	4	5	6	7	8	9	10	11	12

*p<.05.
**p<.01.

these variables were the least intercorrelated with other members of their respective sets. The Picture Integration Test was even more highly correlated with Vowel Extension than it was with three of the six other decentration variables. Furthermore, of the decentration tasks, only Continuous Quantity was as highly correlated with Vowel Extension as the Picture Integration Test.

The results of the second factor analysis, using intercorrelations controlled by grade level, are found in Tables 5 and 6.

Insert Table 5 about here

Table 5 indicates that while the loadings on each factor had been slightly reduced by controlling for grade level, they were still very high, and the factors remained very distinct. Furthermore, the correlation between the two factors ($r = .36$), though reduced, remained significant at the .01 level.

Insert Table 6 about here

Table 6 indicates that the pattern of intercorrelations also remained the same, though the intercorrelations were, as expected, somewhat reduced. Examination reveals that 18 of the 35 intercorrelations between the two sets of variables remained significant at at least the .05

TABLE 5

OBLIQUE FACTOR PATTERN MATRIX FOR DECENTRATION AND SPELLING VARIABLES USING PARTIAL CORRELATIONS (GRADE CONTROLLED)[a]

Variable	Factor 1	Factor 2
Number	.61	-.02
Mass	.77	-.03
Cont. Quant.	.79	.16
Weight	.78	.04
Volume	.61	-.01
Class Incl.	.66	-.08
P.I.T.	.58	.04
Lax Vowel	.15	.79
Tense Vowel	-.09	.80
Marker	.01	.84
Doubling	-.02	.90
Vowel Ext.	.02	.74

[a]Correlation of Factor 1 with Factor 2 = .36 ($p<.01$).

TABLE 6

PARTIAL CORRELATIONS OF DECENTRATION AND SPELLING VARIABLES (GRADE CONTROLLED)

1.	Number											
2.	Mass	.19										
3.	Cont. Quant.	.57**	.55**									
4.	Weight	.46**	.56**	.72**								
5.	Volume	.27*	.44**	.37**	.46**							
6.	Class Incl.	.30**	.42**	.42**	.29*	.26*						
7.	P.I.T.	.20	.41**	.45**	.25*	.23*	.45**					
8.	Lax Vowel	.27*	.40**	.47**	.42**	.13	.11	.27*				
9.	Tense Vowel	.28*	.07	.32**	.13	.19	.09	.04	.60**			
10.	Marker	.15	.15	.38**	.29*	.22*	.21*	.20	.60**	.58**		
11.	Doubling	.11	.24*	.34**	.29*	.18	.17	.23*	.72**	.56**	.70**	
12.	Vowel Ext.	.03	.22*	.31**	.19	.20	.18	.32**	.54**	.39**	.54**	.65**
		1	2	3	4	5	6	7	8	9	10	11	12

*p<.05.
**p<.01.

level, even after grade level had been controlled. Continuous Quantity remained significantly correlated ($p<.01$) with each of the spelling categories. The Lax Vowel category remained significantly correlated with Mass, Weight, and Continuous Quantity ($p<.01$) as well as with Number and the Picture Integration Test ($p<.05$). Finally, the correlation between the Picture Integration Test and Vowel Extension, though reduced, remained significant at the .01 level.

Summary

An analysis of variance of the 30 spelling scores of the 60 subjects revealed that there were significant main effects for grade and spelling category, as well as a significant interaction between grade and category. There was a general increase in scores as grade level increased, though the total of category mean scores were unexpectedly lower for grade one than for grade two. The mean scores for grades one and two were substantially lower than the mean scores for grades three and four across all categories, though there was also a large difference in mean scores between grades three and four for B_5, the Vowel Extension category. There was also a general decrease in scores for each grade as the level of the spelling category increased. A ceiling effect was noted for grades three and four on the first three categories, while grades one and two did poorly on the last three

categories, with B_5 being slightly more difficult.

A canonical correlation was obtained ($r = .67$, $p<.01$) linking the sets of decentration and spelling variables. A factor analysis indicated that there were two distinct factors, one for the decentration tasks and one for the spelling categories. These factors were themselves highly correlated ($r = .56$, $p<.01$). A second factor analysis, in which the effects of grade level on the intercorrelations was controlled, produced the same general patterns as the first factor analysis, though the amount of variance accounted for was somewhat reduced. The two factors remained quite distinct and correlated ($r = .36$, $p<.01$).

Several specific intercorrelations were noted. Continuous Quantity was the decentration task most highly correlated with the spelling categories, maintaining a .01 level of significance with each spelling category, even after grade level had been controlled. The Lax Vowel category was the spelling variable most highly correlated with the decentration tasks, especially with Mass, Weight and Continuous Quantity, retaining a .01 level of significance for the correlations with each of these even after grade level was controlled. Finally, the correlation between the Picture Integration Test and Vowel Extension was also significant at the .01 level in both factor analyses.

CHAPTER V

DISCUSSION

Spelling Strategies

The results of the analysis of variance supported the three hypotheses generated about how children at different grade levels would attempt to spell different kinds of words. First, as the grade level increased the children seemed to use more sophisticated spelling strategies. This held across all categories. However, the second grade was an exception. Not only were the spelling responses similar to first grade attempts, but the performance of the second graders on the decentration tasks was also comparable to that of the first graders. It was the subjective judgment of the investigator and the testers involved in the study that this particular class was an academically below average second grade. A later communication with the class's teacher confirmed this opinion. Although all the second grade classes were supposed to be heterogeneous, she believed that on the whole the children were performing closer to first grade rather than second grade expectancies. This factor may account for the large differences between grades two and three across all categories, clearly illustrated in Figures 1 and 2. The unusual make-up of the class may

also explain the much higher number of unclassifiable responses for this class than for any of the other three.

The results of the analysis also supported the hypothesis that across all four grades differences in categories would lead to differences in performance. The Lax and Tense Vowel categories seemed of comparable difficulty, while the Tense Marker and Consonant Doubling categories were also equally difficult though noticeably more difficult than the first two categories. Finally, the Vowel Extension category was clearly more difficult than the other four.

It was also predicted and confirmed that the children would use varying strategies depending upon both the grade level of the child and the particular category involved. In order to obtain more descriptive information about how the children approached the exemplars within the different categories, frequency counts were tabulated of the strategy levels used for each category by the children in each grade. These can be found in Appendix C and will be used as the basis of the following more specific discussion.

The children in this study seemed to rely on three different strategies in spelling lax vowels. First grade attempts were about equally divided between a closest tense vowel strategy and a correct lax vowel strategy, with a lower but fair number of transitional attempts. This supported the findings of recent

investigations (Beers, 1974; Henderson & Beers, 1974; Read, 1971, 1973). Furthermore, second, third, and fourth grade spellings indicated a progressive decrease in nearest tense vowel strategies (minimal by third grade). Transitional attempts, on the other hand, were much slower to disappear, showing even slight increases in grades two and three. Through all the grades, however, the most prevalent strategies involved using the correct vowel, with almost perfect use of the proper lax vowel by grade four. These findings were not unexpected. Since the children were tested toward the very end of the school year, even the first graders had the benefit of a year's instruction and a year's experience with written words. Furthermore, lax vowels are traditionally dealt with during the first year of school. What is essential to the theoretical basis of this study, however, is that the children did employ systematic ways of spelling the lax vowels, and that more of the spellings conformed to the standard orthographic representation as familiarity and maturity increased.

Tense vowel spellings indicated a movement from a letter-name strategy to a mastery of the marking system which structures the spelling of the English tense vowels. The first graders in particular seemed unaware of this system, with 60% of their attempts being categorized as letter-name. Of the classifiable attempts of the second grade pupils, a much higher proportion showed evidence of

a working knowledge of marking principles. Third and fourth graders, as expected, performed extremely well on these words, with over 90% of the fourth grade spellings utilizing at least possible vowel marking patterns.

However, a use of letter-name strategy did persist into the third grade (17 occurrences). Furthermore, there was no strong evidence for any transitional stages. It seemed that when the marking system was used in the spelling responses, it was handled correctly in all grades. It may be that this finding was due to the immaturity of the second grade sample, and that an average second grade would have provided responses in which transitional strategies were used. But it is also possible that the ability to integrate both the marking system and phonetic principles was more cognitively demanding than mastering either system separately. Thus knowledge of marking principles might have been masked by an inability to use both systems simultaneously. However, there is not enough evidence at the present time to warrant a final statement on this point.

The next two categories, Tense Marker and Consonant Doubling, were characterized by a high proportion of 0 responses in both grades one and two. There does seem to be a reasonable explanation of this phenomenon, however. Most of these unclassifiable attempts were spellings of the base word without the inflectional ending (trim for trimmed, for example). Southern speech in general, and

rural Virginian dialect in particular, has shown a tendency to drop inflectional endings (Wise, 1957). Thus trimmed may be rendered phonetically as /trim/ rather than /trimd/. Given this fact, it may be that many of these unclassifiable responses were in reality letter-name strategies.

For the Tense Marker category, the data indicated that correct use of the marking system emerged rather abruptly at the third grade level. It seemed that once the need for the marking system was realized, its implementation developed quite rapidly. Again, the noted general immaturity of the second grade sample limits the conclusions that can be drawn on this point.

The Consonant Doubling category, on the other hand, showed a somewhat different developmental pattern in the third and fourth grades. Though the children went beyond letter-name strategies, a considerable number of third grade responses revealed an unawareness of the doubling principle, while at the same time a smaller but still significant number of attempts showed an over-extension of the principle. (The frequency count data is somewhat misleading on this point, since a 2 rating indicating no doubling could only be observed on the lax vowel exemplars (for example, humming), while a 3 rating was only possible on tense vowel exemplars (for example, wading). Thus, for comparative purposes, the percentage of occurrence of these two ratings should be higher than

the frequency counts in Appendix C suggest.) For the fourth grade, awareness of the doubling principle had increased, while overgeneralization remained at about the same level. The difference in the two classes was also reflected in the increased number of correct attempts by the fourth graders. Once more the developmental pattern can be reasonably explained in terms of two factors: an increased familiarity with the kinds of words under consideration and the creation and testing of a set of underlying rules. The number of overgeneralization responses for Consonant Doubling supports this contention.

The Vowel Extension scores indicated that this category was definitely the most difficult. Once again a high proportion of first and second grade scores were unclassifiable. An examination of the responses revealed younger children often left out whole syllables and blocks of letters, usually at the point of most interest, around the unaccented syllable of the second word in the pair. Unfamiliarity with polysyllabic words was most likely a cause of such responses. However, it is also possible that letter-name strategies were affected by constraints on short-term memory. If the children attempted to move across the word in a letter-name fashion, the increased time needed to process the longer words may have led to a short-term memory overload for the younger children. As a result, the phonetically least prominent parts of these words, the unaccented syllables, were

omitted from the spelling attempts.

The letter-name strategies of first and second grade children were characterized by the omission of the schwa vowel from the unaccented syllable (for example, combnation for combination). Very few of the responses for these children went beyond a simple letter-name approach.

Third and fourth grade responses, on the other hand, showed a much more consistent use of a vowel in the unaccented syllable. However, a substantial number of third and fourth grade attempts were also based on a letter-name strategy. Furthermore, only 12% of the third grade responses, and only 40% of the fourth grade attempts showed the use of the same vowel in both accented and unaccented positions. For the fourth graders, the great majority of these were correct spellings. It would seem once again that familiarity and experience were factors in the way the children approached the spellings of these words. But the attempts also seemed to involve growing concepts of how words work. The principle of Vowel Extension, demanding generalizations and the creation of structures over classes of related words, seems to require a highly sophisticated understanding of the way words work, apparently fully mastered sometime beyond the fourth grade level.

In summary, the spelling data from this investigation generally supports the argument that children

progressively develop more sophisticated strategies for dealing with English orthography. However, the transitional stages for Tense Vowel and Tense Marker categories discovered in earlier research were not noted in the present study. Several possible explanations for this fact were suggested, but the immaturity of the second grade sample limited the applicability of the present data, especially in regard to transitional stages.

Decentration and Spelling Strategies

The results of the canonical correlation and the two-factor analyses confirmed the investigator's original general hypothesis that performance on the decentration battery and levels of spelling strategies for each category would be significantly correlated. The fit of the two-factor solution indicated that these two sets of variables did indeed measure different things, but the correlation between the two factors confirmed that decentration and levels of spelling strategies were significantly related.

It was anticipated that one might argue that these two sets of variables were related not because of a similarity in underlying processes, but because they were both related to a third factor, years in school. Thus one might argue that spelling success was simply a matter of exposure to a learning situation, and that since the older children were both more mature (since they were

older) and had been in school longer, it would not be at all surprising that the two sets of variables were correlated. The purpose of the second factor analysis, using the partial correlations generated when grade was controlled, was to minimize that part of the variance predictable by between-grade differences, both maturational and experiential. The findings were that the factor pattern remained essentially the same, and that the two factors were still significantly correlated. This provides empirical data supporting the argument that the structures needed to deal effectively with English orthography are similar to the structures that must be invented in order for a child to move from preoperational to operational thinking.

Two specific sets of intercorrelations seem especially interesting. The particularly high correlations between the first and easiest spelling category, the Lax Vowel category, and the decentration variables suggests that the qualitative difference between preoperational and operational thinking is most important for spelling at that time when the child <u>first</u> moves from a letter-name strategy to more abstractly based relational structures. Because of the effects of the Great Vowel Shift on the English sound-spelling system, a true understanding of the lax vowel spellings necessarily involves a transformational system that goes beyond the merely perceptual relationships evident in letter-name spellings. More

difficult spelling category strategies, though probably facilitated by more stable concrete operational thinking, did not seem quite as directly related to cognitive development.

The second interesting correlation was the significant relationship in both factor analyses between the Picture Integration Test and Vowel Extension. Both variables specifically dealt with perceptual relationships between parts and wholes. It may very well be that the ability to internalize the relationship between combine and combination requires the same kind of active, systematic perceptual exploration necessary for success on Elkind's part-whole test.

Concluding Remarks

Modern theorists (Chomsky, 1970; Chomsky & Halle, 1968; Venezky, 1967; Weir & Venezky, 1968) have argued that English orthography is a highly regular system based on the interaction of deeper levels of processing and the apparently less regular surface structure. Recent researchers (Beers, 1974; Henderson and Beers, 1974; Read, 1971, 1973) have shown that a child's awareness of how the surface structure interacts with these levels seems to evolve over time. A conceptual understanding of the way words are constructed seems to follow a systematic, progressive sequence of development. The present study has attempted to examine this developmental sequence as

Beers, Henderson, and Read have done, and to extend the analysis to older children and to words which would theoretically seem to demand a higher level of understanding.

In Chapter II the generative developmental theory of orthographical relationships was placed in the context of Piaget's more general theory of cognitive development. Special care was taken to elaborate the relationship between word knowledge and decentration which an integration of the two theories logically implies. Thus a second purpose of this study was to explore the relationship between the strategies a child uses when trying to spell certain types of words and his ability to decenter, to consider multiple aspects of a given situation simultaneously.

The results obtained do suggest that there are developmental stages of word knowledge dependent upon 1) cognitive structures available to the child, and 2) the complexity of the particular word he is trying to spell. These stages are also significantly correlated with decentration, even when the effects of grade level are controlled.

APPENDIX A

SPELLING LISTS

LIST OF EXEMPLARS

Lax Vowels

a:	craft (21)*	e:	hem (14)	i:	drift (36)
	damp (27)		speck (13)		skid (3)

Tense Vowels

a:	tame (25)	e:	creep (36)	i:	spike (5)
	scrape (18)		thief (28)		slime (4)

Past Tense Marker

/t/:	cramped (8)	/d/:	bragged (5)	/Id/:	dented (3)
	raked (13)		stabbed (9)		cheated (18)

Consonant Doubling

Lax Vowels:	humming (20)	Tense Vowels:	wading (15)
	trimmed (42)		striped (7)
	flopped (5)		dining (A)

Vowel Extension

a:	inflame (7)	e:	compete (11)
	inflammation (2)		competition (28)
	explain (AA)		repeat (A)
	explanation (31)		repetition (10)
i:	combine (A)		
	combination (40)		
	inspire (32)		
	inspiration (18)		

*Numbers in parentheses are the occurrences of the word or its uninflected per million words in the Thorndike and Lorge (1944) overall count. A indicates a word occurs between 50 and 99 times per million words. AA indicates a word occurs 100 or more times per million words.

SPELLING LIST I

1.	dented	John dented his car when he hit the post.
2.	creep	The baby had to creep on the floor to reach his toy.
3.	bragged	Yesterday John bragged about his shiny new bike.
4.	compete	Willie liked to compete in all games.
5.	spike	Jack tore his pants on a spike while climbing a fence.
6.	competition	Willie wanted to win the game, but he had lots of competition.
7.	drift	Most children would like to drift down a river on a raft like Tom Sawyer.
8.	wading	In the summer we go wading in a pool or creek.
9.	combine	I like to combine peanut butter with jelly when I make sandwiches.
10.	tame	Lions are wild but kittens are tame.
11.	combination	Peanut butter and jelly make a good combination.
12.	humming	Humming birds make pretty sounds.
13.	striped	We sure like red and white striped candy canes.
14.	craft	Some children learn the craft of basket making in school or at summer camp.
15.	inflame	Dirt and germs inflame a cut, and can make it red and sore.
16.	hem	Susan's mother sewed the hem on her dress.
17.	inflammation	If you don't take care of cuts and scrapes you can get a nasty inflammation.
18.	cramped	The tall man's legs were cramped from sitting in the back of the small car.

SPELLING LIST II

1.	slime	Frogs like the slime on the pond.
2.	trimmed	Last Christmas, we trimmed the tree with pretty colored balls.
3.	scrape	Hank fell and got a bad scrape on his knee.
4.	repeat	The teacher had to repeat her instructions.
5.	dining	We eat our dinner in the dining room.
6.	repetitions	The teacher was upset because after so many repetitions some children still didn't understand the instructions.
7.	raked	Last fall we raked up all the dead leaves.
8.	thief	A thief takes things that don't belong to him.
9.	explain	John asked us to explain again because he didn't understand.
10.	skid	If you drive too fast in the rain, your car may skid off the road.
11.	explanation	John asked us for another explanation because he didn't understand us.
12.	cheated	Mike had cheated in order to win the game.
13.	stabbed	Jane accidentally stabbed her friend with her pencil.
14.	speck	When the wind blows, I often get a speck of dust in my eye.
15.	inspire	The coach tried to inspire his team by giving them a pep talk.
16.	damp	The scary old house was cold and damp.
17.	inspiration	The coach's talk gave his team the inspiration they needed to win.
18.	flopped	Last night Ralph was so tired that he flopped down on his bed and fell fast asleep.

APPENDIX B

DECENTRATION BATTERY

DECENTRATION TASKS: PROCEDURES

1) Conservation of Mass

Equipment - playdoh, screen

Procedure - Use the playdoh to make two balls of equal size. Show these to the child and make sure that he agrees that they both have the same amount. If he does not agree, adjust the size of the balls until he considers them equal. Put one ball behind the screen and leave the other in front of the child. Roll the ball in front of the child into a sausage. Now ask the child if the same ball you rolled into the sausage still has the same amount, or if it has more or less than it did before. (It is important that you give the child the three choices so that he does not base his decision on what he thinks you want him to say.) Then ask him to explain his reasoning. Next, bring the other ball out from behind the screen, reminding the child that the two balls were originally of the same amount, and that you have neither added any doh to them or taken any away. With both the ball and the sausage in front of him, ask the child whether they have the same or different amounts. Next ask him to explain his reasons.

2) Conservation of Number

Equipment - eight plastic poker chips of one color and eight of another color, screen

Procedure - Assemble the chips into two differently colored lines of the same length. Show these to the child and have him agree that both lines contain the same amount by counting the number of chips in each line. Now place the screen between the two rows so that the child can only see one row. Change the length of the row he can see by moving the chips farther apart. Now ask the child if that row has less, more or the same as it did before. Then ask the child to explain his reasoning. Next, remove the screen, reminding the child that the rows were originally the same, and that you have neither added nor taken away any chips. Now ask the child whether one row has more or less than the other or whether they both have the same amount. Ask him to explain his reasoning.

3) Conservation of Continuous Quantity

Equipment - two identical clear plastic cups, one differently shaped cup, water, screen

Procedure - The procedure is almost identical to that used for the conservation of mass. Now the shape of the material is determined by the shape of the container rather than by the tester's manipulation of solid material.

4) Conservation of Weight

Equipment - playdoh, screen

Procedure - Same as for conservation of mass, except that decisions are made in regard to the weight of the playdoh, rather than in regard to its mass. Thus the child may hold a ball in each hand in order to agree that they weigh the same. However, once the shape of the ball is changed the child should not be allowed to weigh the objects in his hands again. His judgment should be based on what he thinks should be true rather than on the actual physical sensation of the playdoh in his hand.

5) Class Inclusion I

Equipment - paper triangles and squares (there should be more of one than the other), box

Procedure - Show the child the squares and trinagles. He must understand that they are all paper. He must also agree that there are more of one than the other. Now ask the child whether there are more square (or triangle) things or more paper things. Ask him to explain his reasoning.

6) Conservation of Volume

Equipment - two beakers equally filled with water (about half way), two equal balls of playdoh, screen

Procedure - Again, basically the same as conservation of mass. Now the judgments are made on the change in the level of water in the cups if the playdoh were put in the water. Again, however, the playdoh should not be put in the water. The decisions should be made on what the child thinks should happen rather than on the physical perception.

7) Class Inclusion II

Equipment - plastic poker chips, two different colors (there should be more of one than the other)

Procedure - Same as class inclusion I, now ask the child

if there are more of the greater number colored chips or more plastic chips. Ask him to explain his reasoning.

Scoring Criteria

On the conservation problems, there are two questions, one based on the change in an object itself (identity) and one based on the change in relation to a similar object (equivalence). These two should be marked yes if the child makes the correct judgment. Under each, however, is category for the child's reasoning. As much as possible of the child's explanation should be recorded, and the reasoning category should be marked yes only if the child's reasoning is directly related to the question, and only if it makes sense. It should be based on logic rather than on the specific perceptual situation. Thus a response like "they look like they're about the same." is not acceptable, though the tester may wish to ask for a further explanation. Correct responses are usually based on one of two principles: compensation or reversibility. An example of compensation would be: "now its longer but thinner," while reversibility is dependent on the child's ability to see that one could return to the former state: "if you squished it back together it would be the same as before." In any case, the tester should be careful that his decision is based on what the child understands, rather than simply on the correct verbal response.

DECENTRATION TASK SCORING SHEET

Name_____ Grade_____ Date of Birth_____

1) Mass:

Response

Identity_____
Reasoning_____

Equivalence_____
Reasoning_____

2) Number:

Response

Identity_____
Reasoning_____

Equivalence_____
Reasoning_____

3) Continuous Quantity:

Response

Identity_____
Reasoning_____

Equivalence_____
Reasoning_____

4) Weight:

Response

Identity_____
Reasoning_____

Equivalence_____
Reasoning_____

5) Class Inclusion I:

Response

Correct_____
Reasoning_____

6) Volume:

Response

Identity_____
Reasoning_____

Equivalence_____
Reasoning_____

7) Class Inclusion II:

Response

Correct_____
Reasoning_____

Name of Tester:_____

PICTURE INTEGRATION TEST

Instructions for Administration

The child is first told "I am going to show you some pictures one at a time. Look at the pictures and tell me what you see or what they look like to you."

Begin with the first picture, holding it about a foot from the subject, arrow pointing up, and ask the child "What do you see?" If the child does not see both parts and wholes, he is asked "Anything else?" After that, only responses that need clarification are questioned, and only spontaneous responses are recorded. Occasionally, however, a child might perseverate on parts of the parts. For example, he replies "giraffe" to your first question, and when you ask "Anything else?", he says "spots" etc. You may then say "Yes, those are all parts of the giraffe. Anything else?".

Use the scoring sheet provided. Copy down as much of what the child says as possible. We are interested in discovering how the child perceives the parts and wholes, rather than in his ability to correctly name the objects. Thus, if a child mislabels an object, for example, calls the giraffes zebras, he receives credit for naming the parts. Furthermore, the child may see the wholes and parts without describing them fully. He might say "Candy canes making the handlebars" or "An orange head" etc. In such a case the child should be given full credit for integrating parts and wholes even if he fails to elaborate further.

Scoring Scale

Parts - 1 Wholes - 2 Parts and Wholes (Sequential) - 3
Parts and Wholes (Integrated) - 4

The difference between sequential and integrated recognition depends on whether the child recognizes the parts and wholes in sequence, that is, one and then the other, e.g. "vegetables" and then "plane" (or "fish") or whether he can integrate the parts and wholes into a single act of recognition, e.g. "a bike made out of candy." This may involve a subjective decision on your part. When you are unsure give the child the lower score and note your uncertainty on the scoring sheet.

PICTURE INTEGRATION TEST SCORING SHEET

Name_____ Grade_____ Date of Birth_____

1) Giraffes - Heart:

Response

Parts_____
Whole_____
Both (Sequential)_____
Both (Integrated)_____

2) Vegetables - Plane (Fish):

Response

Parts_____
Whole_____
Both (Sequential)_____
Both (Integrated)_____

3) Candy - Bike (Scooter):

Response

Parts_____
Whole_____
Both (Sequential)_____
Both (Integrated)_____

4) Fruit - Rabbit:

Response

Parts_____
Whole_____
Both (Sequential)_____
Both (Integrated)_____

5) Fruit - Man:

Response

Parts_____
Whole_____
Both (Sequential)_____
Both (Integrated)_____

6) Electrical Equipment - Face:

Response

Parts_____
Whole_____
Both (Sequential)_____
Both (Integrated)_____

Picture Integration Test Scoring Sheet

7) Toys - Face:

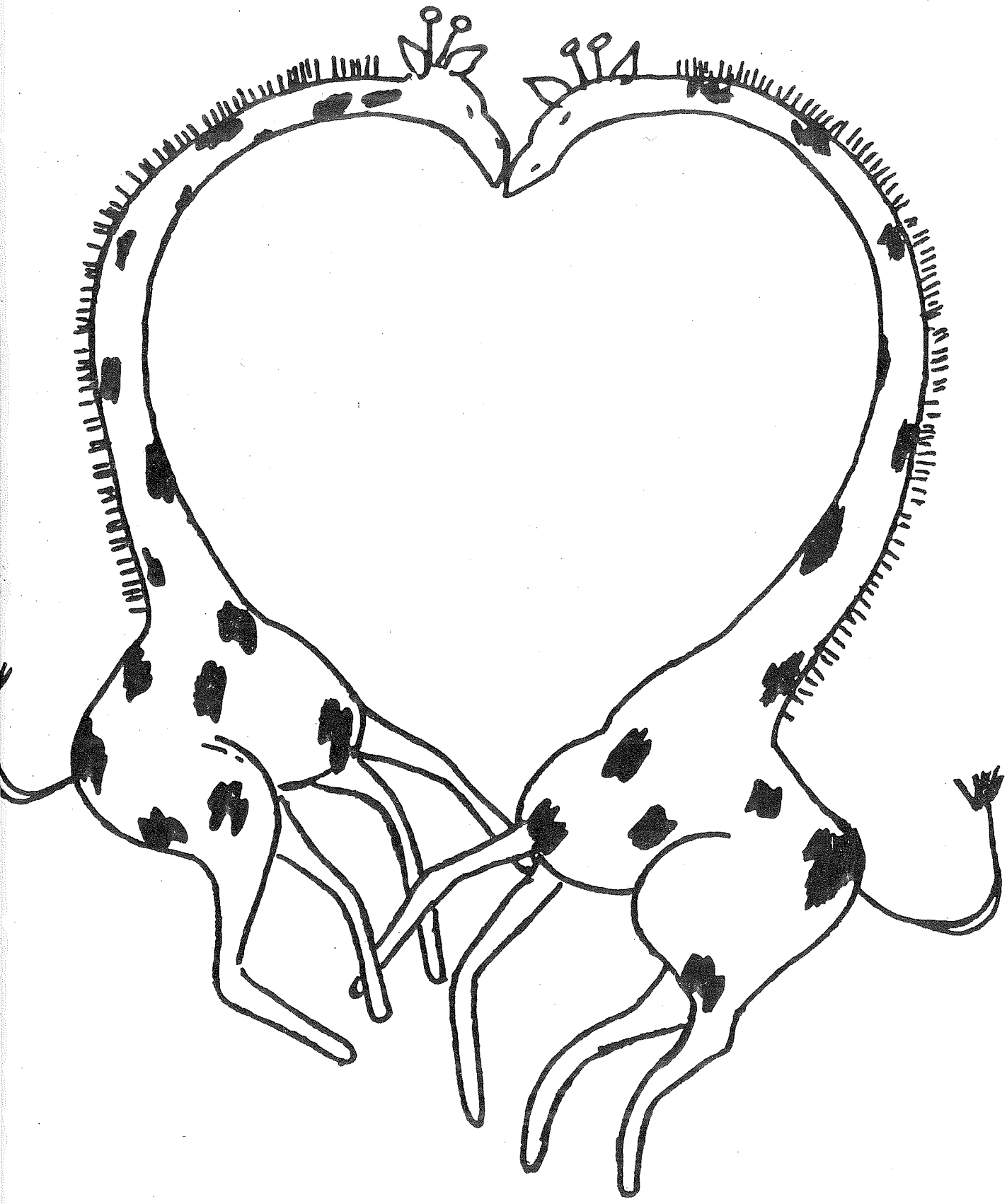
Response

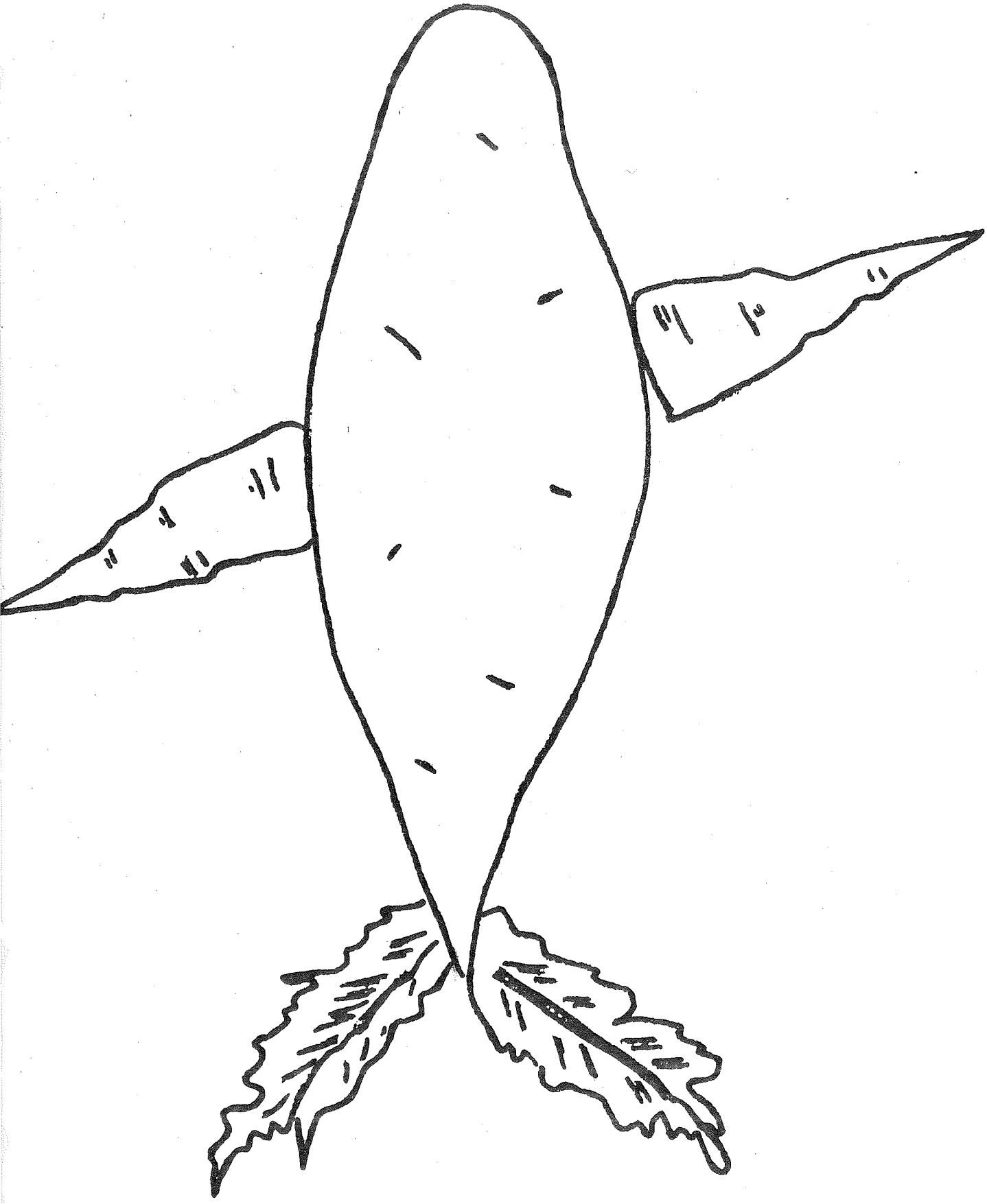
Parts_____
Whole_____
Both (Sequential)_____
Both (Integrated)_____

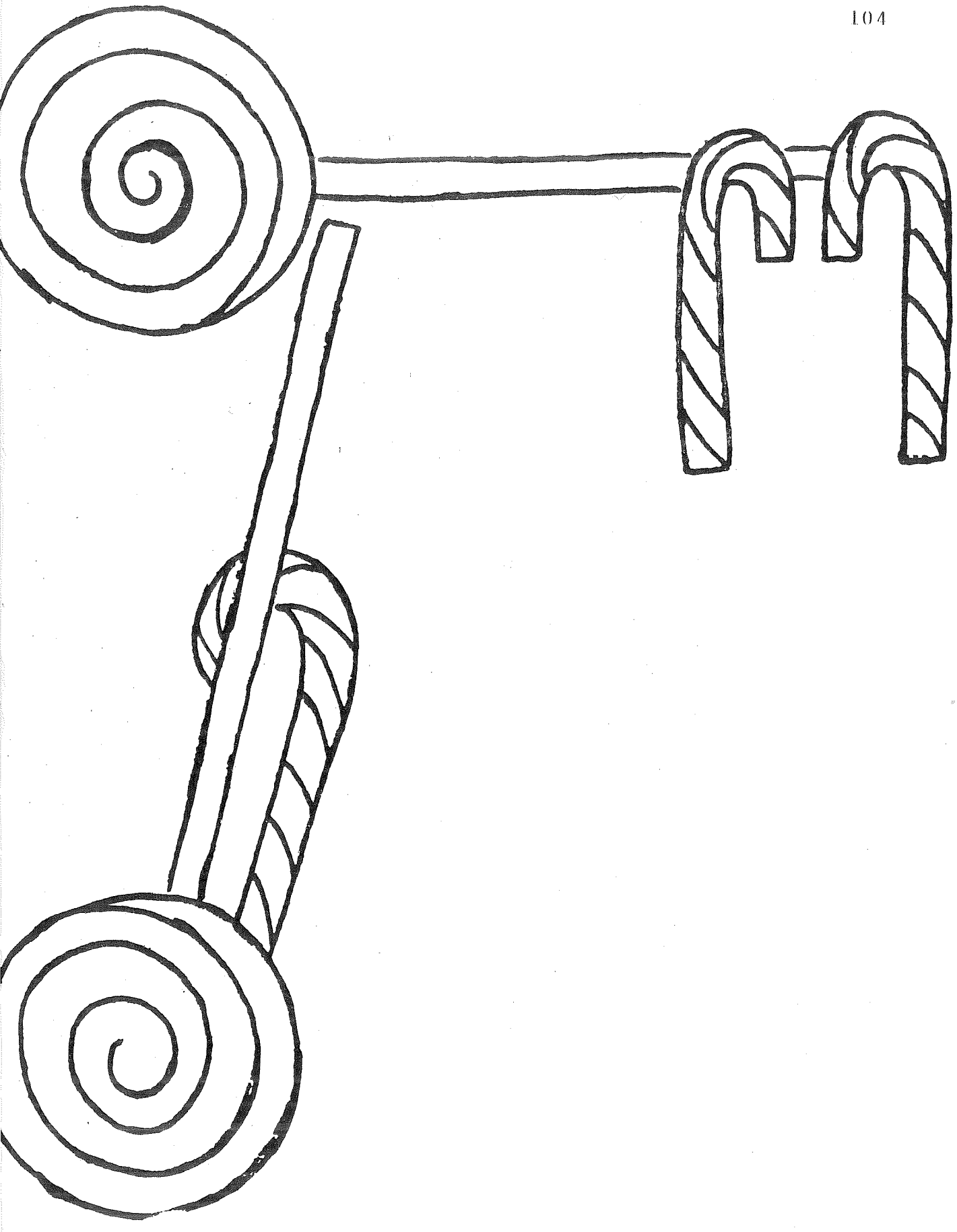
General Comments

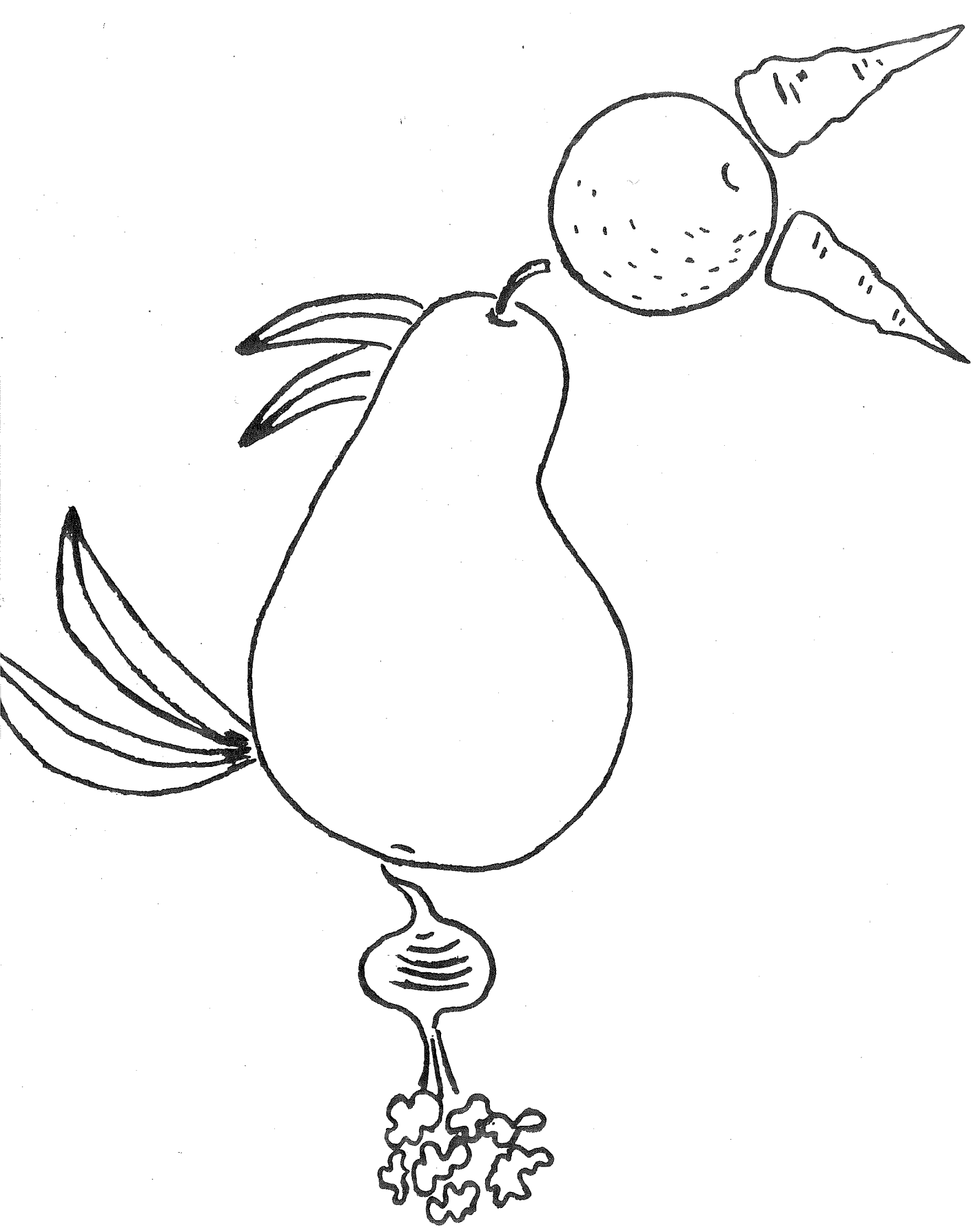
Name of Tester:

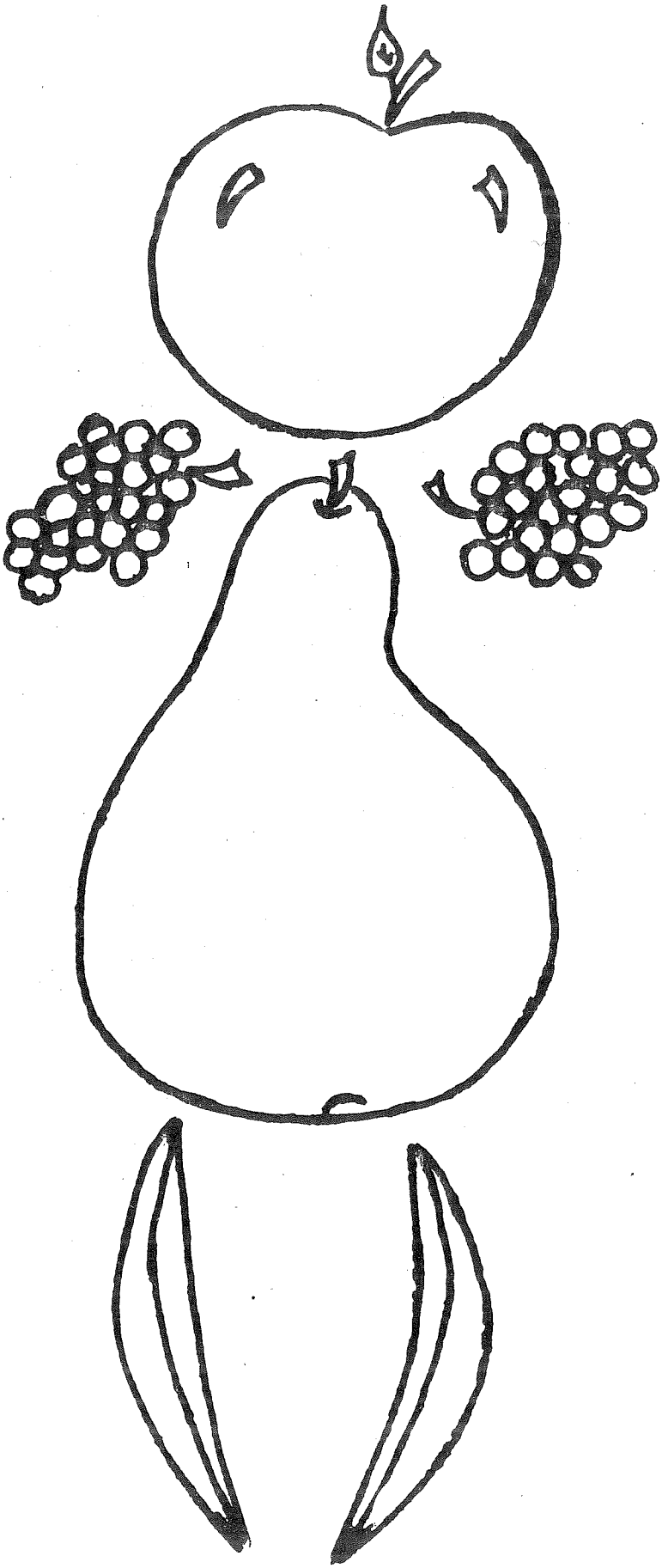
_____

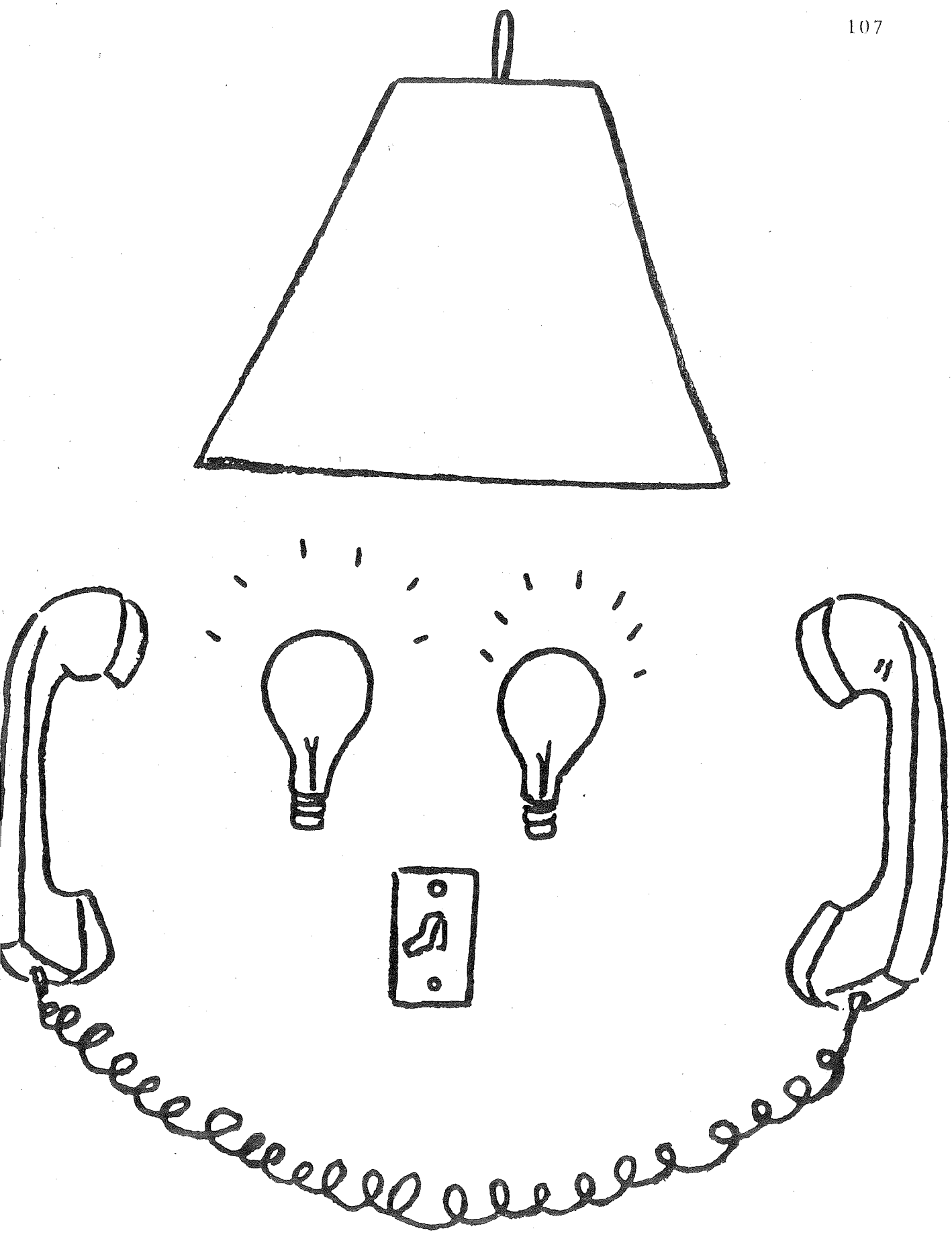


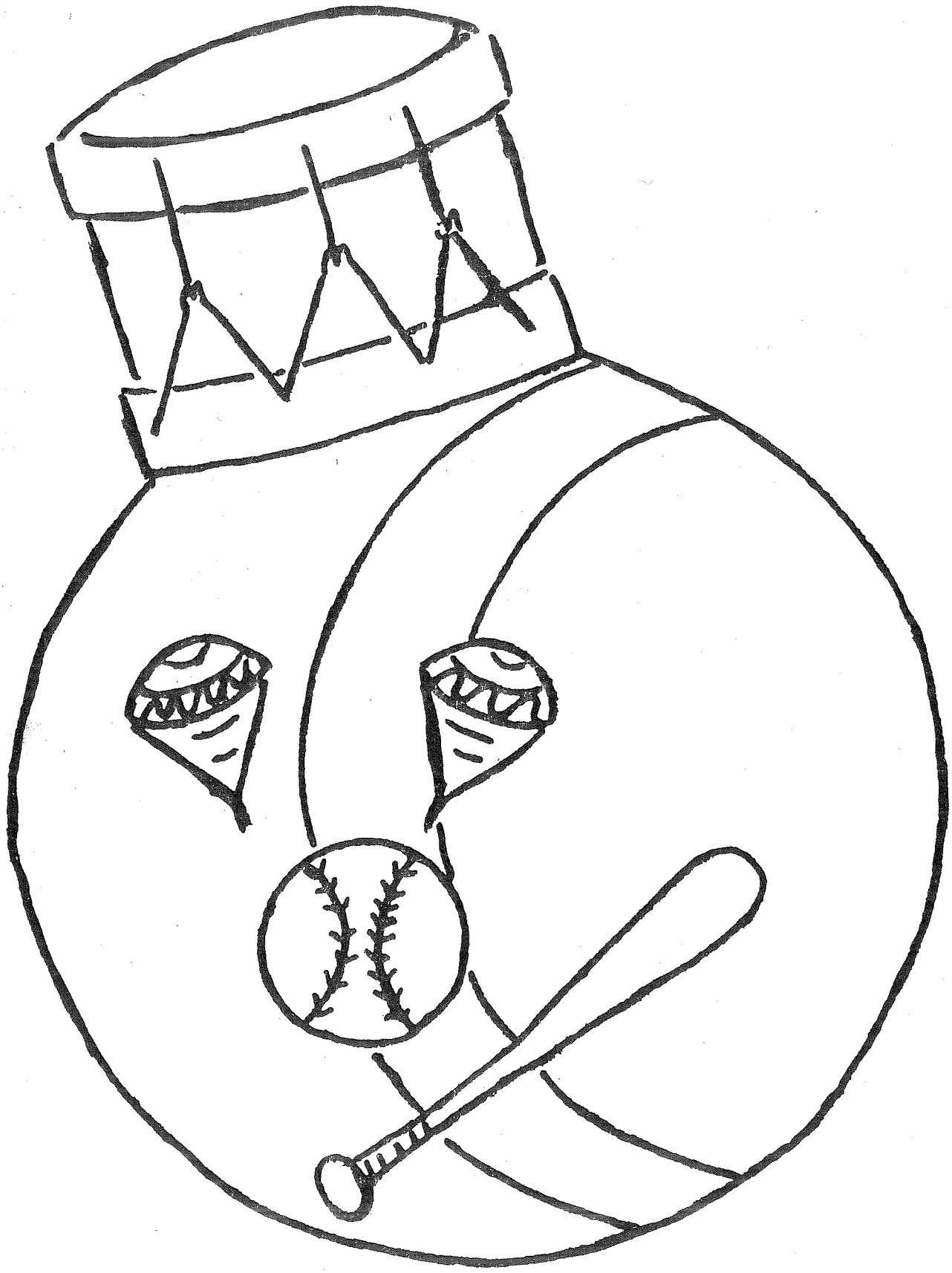












APPENDIX C

FREQUENCY COUNTS OF STRATEGIES FOR EACH SPELLING CATEGORY

Grade 1

	Lax Vowel	Tense Vwl.	Marker	Doubling	Vowel Ext.
0*	5	5	49	45	33
1-2	3	54	20	18	43
3-4	30	2	8	8	13
5-6	13	4	6	0	1
7-8	34	13	5	8	0
9-10	5	12	2	11	0

Grade 2

	Lax Vowel	Tense Vwl.	Marker	Doubling	Vowel Ext.
0	28	23	49	53	55
1-2	7	18	14	8	27
3-4	13	11	5	8	4
5-6	15	4	5	2	2
7-8	10	13	10	13	2
9-10	17	21	7	6	0

*Counts are based on the sum of the two raters' scoring.

Grade 3

	Lax Vowel	Tense Vwl.	Marker	Doubling	Vowel Ext.
0*	1	0	11	7	10
1-2	0	17	2	2	29
3-4	5	2	0	28	40
5-6	20	1	0	10	7
7-8	16	28	39	11	3
9-10	48	42	38	32	1

Grade 4

	Lax Vowel	Tense Vwl.	Marker	Doubling	Vowel Ext.
0	0	0	6	11	7
1-2	0	5	3	1	15
3-4	3	2	0	11	31
5-6	4	0	0	12	4
7-8	18	19	24	5	8
9-10	65	64	57	50	25

*See note p. 111.

APPENDIX D

EXPECTED MEAN SQUARES FOR THE ANALYSIS OF VARIANCE

Source	Expected Mean Squares				
A	σ^2	$+30\sigma^2_{SA}$			$+450\theta^2_A$
S(A)	σ^2	$+30\sigma^2_{SA}$			
B	σ^2		$+6\sigma^2_{BSA}$	$+60\sigma^2_{DCB}$	$+360\theta^2_B$
C	σ^2			$+60\sigma^2_{DCB}$	$+126.67\theta^2_{CB}$
D	σ^2			$+60\sigma^2_{DCB}$	
AB	σ^2		$+6\sigma^2_{BSA}$		$+90\theta^2_{AB}$
BS(A)	σ^2		$+6\sigma^2_{BSA}$		
AC	σ^2				$+31.67\theta^2_{ACB}$
Error	σ^2				

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