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ABSTRACT

A study examined the spelling of reading disabled (RD) and average ability students within the context of the developmental lag hypothesis, which was then contrasted with a developmental difference hypothesis. Subjects were 38 regular class third graders and 18 average intelligence fifth graders receiving resource room assistance for reading difficulties. Third grade regular class students were matched on spelling with fifth grade reading disabled students (achieving two years below grade level); average and below average spellers were identified in each class. As part of a larger study examining the relationship between cognitive processing and reading ability, subjects were administered achievement tests, cognitive processing tests, and a computerized spelling test. Hypothesized underlying cognitive processes of memory access, memory span, simultaneous and successive processing, and phonological processing were examined and related to spelling performance. In addition, spelling errors made by the different groups on words differing in word familiarity and spelling predictability were analyzed using a developmental model of spelling. Results showed (to a limited extent) that the underlying cognitive processing supported the developmental lag hypothesis. The analysis of spelling errors much more strongly supported the notion that poor spellers were learning to spell according to a normal developmental pattern but at a much slower rate. In addition, the patterns identified through the analysis of spelling errors provided better diagnostic and instructional information than the analysis of underlying cognitive processes. (Thirty-three references and six tables of data are attached.) (RAE)

Analysis of Spelling Errors Made By Average Ability and Reading Disabled Children: Evidence for a Developmental Lag?

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Abstract

A developmental lag hypothesis was contrasted with a developmental difference hypothesis in this exploratory analysis of spelling ability. Third grade regular class students were matched on spelling with fifth grade reading disabled students (achieving two years below grade level); average and below average spellers were identified in each class. Hypothesized underlying cognitive processes of memory access, memory span, simultaneous, and successive processing, and phonological processing were examined and related to spelling performance. In addition, spelling errors made by the different groups on words differing in word familiarity and spelling predictability were analyzed using a developmental model of spelling. To a certain extent, the results obtained for the underlying cognitive processing supports the developmental lag hypothesis. The analysis of spelling errors much more strongly supports the notion that poor spellers are learning to spell according to a normal developmental pattern but at a much slower rate.

Poor spelling is a common diagnostic characteristic of learning disability (LD), reading disability (RD), and dyslexia (Gerber & Hall, 1982, 1987). Recently, a developmental lag hypothesis has been offered to account for the poor spelling of LD, RD, and dyslexic children (Bookman, 1984; Gerber, 1984; Gerber & Hall, 1987). According to this hypothesis, cognitive processes underlying poor spelling ability follow a normal developmental sequence but at a slower rate. As a result, spelling of older, disabled students should approximate that of younger, average ability students. In turn, these similar spelling patterns should relate to similar developmental levels in underlying cognitive processing. This lag hypothesis is contrasted with the more common developmental difference hypothesis in which it is argued that some underlying cognitive process is deficient (or some combinations of processes are deficient) and that this deficiency leads to the ability-related differences in spelling.

Why should we care if disabled spellers lag behind or differ from their non-disabled peers? Following the argument put forward in the reading literature (cf. Seidenberg, Bruck, Fornarolo, & Backman, 1985; Morrison, 1987), researchers and educators seem compelled to distinguish disabled children who can and cannot benefit from remediation that is based on traditional methods of instruction. Thus, being able to pinpoint a diagnosis as a specific disability or combination of disabilities (according to the difference hypothesis) or as a general slowness in progression through relatively normal stages of development (according to the lag hypothesis) has important implications for determining appropriate instruction, or even whether the disability is actually modifiable.

The purpose of this study was to begin to examine the spelling of RD and average ability students within the context of the developmental lag hypothesis. If a lag hypothesis can be used to account for spelling difficulties,

then individual differences in performance by the RD children should be comparable with individual differences in performance by the non-disabled children. If a particular deficit or combination of deficits underlie the spelling difficulties, then these groups should not be comparable. Third grade average ability students were matched on spelling ability with fifth grade, mildly RD students: below and average ability spellers, based on third grade spelling norms, were distinguished within each grade. Disabled children achieving at a maximum of two years below grade level were selected in order to rule out any obvious intellectual or neurological impairments that could put the disabled children at particular risk for being poor spellers.

Tasks aimed at measuring hypothetical underlying cognitive processes were administered and related to developmental level of spelling. This is not a simple endeavor, however, because a very large number of related and distinct processes have been investigated and determined to somehow contribute to spelling. In order to develop some necessary limits, those processes that previous research has indicated may be most fruitful for identifying points at which poor spellers may lag behind (or differ from) their normally achieving peers were selected for analysis in this exploratory study.

Two elementary underlying cognitive processes that have been implicated in spelling are the ability to access long term memory for letters, morphemes, syllables, and/or whole words, and memory for the order in which the letters, morphemes, and/or syllables occur in a word (Luria, 1973; Gerber & Hall, 1987). Results of speeded recognition and decision tasks (cf. Dempster, 1981) demonstrate reliable developmental differences in memory access; older children are quicker than younger children and this developmental trend continues into adolescence. Memory span studies (cf. Dempster, 1981) have been shown to follow a similar developmental trend, with span increasing into adolescence. A

developmental lag in either memory access or span could have an impact on spelling. From a working memory or limited resources perspective, a lag in either or both fundamental processes would have particularly disastrous effects on spelling longer and more complex words. Naming time for single letters and for letter pairs were used as measures of memory access and memory span for letters was used to examine order memory.

The information integration model (Das, Kirby, & Jarman, 1979) can be used to speculate about how higher-order cognitive processes may influence spelling. According to the model, simultaneous processes refer to dealing with entire perceptual entities and with the relationships between the units in the entities. Successive processing is used to refer to segmentation and analysis of the individual units. With the exception of slight developmental variance due to speed of processing, simultaneous and successive processes have been shown to be relatively invariant across development (Das & Malloy, 1975) and ability level (Jarman & Das, 1977).

Although these forms of processing are invariant, this does not mean that their contribution to performance is invariant across ages or abilities. Relating these processes to spelling development, simultaneous processing may be more heavily involved in cue or whole word memorization forms of spelling that are often encountered in young spellers, whereas successive processing may be more important for phonetic and morphemic segmentation used by developmentally more mature spellers. As a result, a developmental lag in these types of spelling strategies might be reflected in different relationships between indices of simultaneous and successive processing and spelling ability. In other words, a relationship between simultaneous processing and spelling may be found at earlier stages of learning to spell whereas a relationship between successive processing and spelling may be found for children at a latter

developmental stage. A modification of the Graham and Kendall (1960) memory for designs test was used to measure simultaneous processing and auditory serial recall (Ashman, 1978) was used to measure successive processing.

Phonological segmentation and processing have most definitely been implicated as skills that are important for early reading (Bradley & Bryant, 1983; Maclean, Bryant, & Bradley, 1987; Perfetti, Beck, Bell, & Hughes, 1987; Seidenberg, Bruck, Fornarolo, & Backman, 1985; Treiman, 1985) and most likely also for spelling (Bradley, 1986; Ehri, 1985; Treiman, 1985; Waters & Bruck, 1985). Regardless of whether experience with print improves phonological skills or vi - versa, improvement in spelling occurs along with improvements in phonological skills and strategies (Ehri, 1985). However, there are many tasks that have been designed to measure phonological processing (e.g. psuedoword reading, phoneme blending, phoneme deletion, tapping, rhyming, etc.); research using these tasks often results in inconsistent differences and relationships. Because it is difficult to distinguish an appropriate task of phonological awareness, rather than arbitrarily deciding on one (or several), children were administered a task that at least theoretically requires these phonological skills, namely word reading (Schonell, 1963). Beyond simple, common words, phonological processes are necessary for correct "sounding out" of complex, unfamiliar words.

In addition to investigating underlying cognitive processes, we also examined developmental spelling level through a more qualitative analysis of spelling errors made by the children. Developmental sequences of spelling have been described by many researchers (cf. Bookman, 1984; Ehri, 1985; Frith, 1980; Gentry, 1984; Read, 1971). In general, these researchers have found children's spelling to progress from precommunicative forms of spelling in which letter sequences, at best, only slightly reflect correct spelling (e.g. t or h),

through several stages reflecting the gradual acquisition and application of increasingly more complex forms of grapheme-phoneme correspondence rules - "phonetics" - to spell new words (chpl to hospdl to hosptil) and rules corresponding to larger units, morphemes (hospitole), to automatic, correct spelling (hospital). Gerber and Hall (1982) found that these stages are still followed by LD students, though at a much slower rate. Replicating Gerber and Hall's results with mildly RD children and relating progress through these different developmental stages to underlying cognitive processes would provide strong support for the developmental lag hypothesis.

Children cannot be so easily and neatly categorized according to a single developmental spelling level, however. Some words are very familiar and may be highly overlearned (such as McDonalds). There is somewhat inconsistent evidence (cf. Cahen, Craun, & Johnson, 1971; Groff, 1982, 1984) that familiar words are more likely than unfamiliar words to be spelled correctly and automatically. Other words are "easy" to spell in that they are phonetically predictable; the word, tap, for example, can easily be spelled correctly merely by analyzing and writing down the letter corresponding to each phoneme in the word. Many words in English, although not maintaining such perfect phoneme-grapheme correspondence, are spelled predictably. That is, they can be spelled correctly by applying a limited number of graphemic, phonemic, and/or phonetically consistent morphemic rules (Venezky, 1970). Thus, once the rules are learned, these predictable words can be easily and successfully spelled even though they may be unfamiliar to the speller. However, there are also many unpredictable words -- words that cannot be spelled correctly by the application of these rules -- and the spelling of these words must also be mastered. These elements of word familiarity and spelling predictability and their effects on spelling were also examined in order to gain a more complete

understanding of the developmental level of spelling. In order to eliminate any effects of poor handwriting skills and collect extensive data concerning how the words were spelled, any corrections that were made, time to spell the words, etc., the spelling test was administered via microcomputer (Varnhagen & Gerber, 1984).

Method

Subjects

The subjects were 38 regular class third graders ($\underline{M}$ = 8.7 years) and 18 average intelligence fifth graders ($\underline{M}$ = 11.1 years, $\underline{M}$ Full Scale IQ = 102.8) receiving resource room assistance for reading difficulties. The regular class and RD subjects were roughly matched on standardized reading comprehension tests. There were an approximately equal number of boys and girls. All subjects were native English speakers and had no apparent perceptual or neurological impairments.

The subjects were divided into spelling ability groups based on their performance on the Edmonton Public School Board spelling achievement test (EPSB, 1981). Subjects who scored below the 50th percentile according to the third grade norms were classified as below average spellers and subjects who scored above the 50th percentile were classified as average spellers (none of the subjects scored at or above the 90th percentile so there were no outstanding spellers in the average group). There were 18 subjects in the regular class below average group, 8 in the RD below group, 20 in the regular class average group, and 10 in the RD average group. The spelling performance of the children in these groups averaged the 23rd, 23rd, 76th, and 71st percentile on the EPSB test, respectively.

Tasks and Procedure

As part of a larger study examining the relationship between cognitive

processing and reading ability, the subjects were administered achievement tests, cognitive processing tasks, and the computerized spelling test. The subset of tasks analyzed in this study were the EPSB spelling achievement test (EPSB, 1981), Schonell word reading test (Schonell, 1963), single and paired letter naming time (Denkla & Rudel, 1976; Varnhagen, Das, & Varnhagen, 1987), memory span for letters (Varnhagen, Das, & Varnhagen, 1987), memory for designs (Graham & Kendall, 1960), auditory serial recall (Ashman, 1978), and the computerized spelling test (Varnhagen & Gerber, 1984). The tasks, their purposes, and measures collected for analysis are summarized in Table 1.

The computerized spelling test consisted of 30 words selected from third grade reading texts. The words were selected on the basis of familiarity and predictability. Familiarity was determined by frequency of occurrence (Carroll, Davies, & Richman, 1971). Unfamiliar words had a spelling frequency of less than 10 and a third grade frequency of less than 50. Familiar words had spelling frequency of greater than 125 and a third grade frequency of greater than 500. Predictability of spelling was determined by ratings made by the first two authors and by two elementary school teachers as to the ease with which common phonetic rules could be used to spell the words. Predictable words could be spelled by application of these common rules. Unpredictable words had irregular spellings in that they violated one or more phonetic rules. There were 11 familiar words with predictable spellings (e.g. word), 4 familiar words with irregular or unpredictable spellings (e.g. were), 11 unfamiliar words with predictable spellings (e.g. bent), and 4 unfamiliar words with unpredictable spellings (e.g. author).

The procedure for the test was adapted from the common dictated words spelling test format: Each word in the test was presented auditorily via cassette tape recorder (e.g. hospital), used in context in a sentence (The

ambulance turned on its siren on the way to the hospital.), and repeated (hospital). The subject then typed his or her spelling of the word on the keyboard of an Apple IIe microcomputer. The subject's exact spelling, including errors and changes made by backspacing, and final spelling of the word was recorded by the computer. Time taken to begin typing once the word had been presented and total time to spell each word was also recorded on the computer. The time data was not analyzed for this report.

The Schonell word reading and memory for designs tasks were administered during the first session; the naming time and memory span tasks were presented on the microcomputer during the second session; the computerized spelling test comprised the third session; and the EPSB spelling achievement test was given in the fourth session. Subjects were seen individually for approximately 20 minutes for the first three sessions which were separated by one day; the intact classroom participated in the fourth session one to two weeks later.

Results and Discussion

Group Differences in Performance

Means and standard deviations for performance on the various tasks are shown in Table 2. Separate two between subjects (class and ability) analyses of variance revealed significant main effects of ability on the EPSB spelling achievement test, $F(1,52) = 82.18$, Schonell word reading test, $F(1,52) = 20.88$, naming time for single letters, $F(1,52) = 10.16$, naming time for letter pairs, $F(1,52) = 22.97$, and on the computerized spelling test, $F(1,52) = 21.56$, $p < .005$. No significant effects of class and no interactions were obtained.

These results -- significant main effects of ability and no interactions -- provide strong support for a developmental lag hypothesis; the below average spelling ability children (both the regular class and the RD children) lag behind the average spellers in speed of memory access, phonological skills

(as inferred from the Schonell), and spelling ability. Overall, the lower ability regular class and RD children demonstrate remarkably similar performance on the various tasks, as do the higher ability regular class and RD children.

This comparability among the two groups of below average spelling ability subjects and among the two groups of average spelling ability subjects is maintained in the analysis of the computerized spelling test as a function of word familiarity and spelling predictability. Table 3 summarizes these results. A two between subjects factors (class and ability), two within subjects (familiarity and predictability) analysis of variance revealed significant effects of ability, $\underline{F}(1,52) = 18.97$, familiarity $\underline{F}(1,52) = 44.33$, predictability, $\underline{F}(1,52)=190.00$, familiarity by predictability, $\underline{F}(1,52) = 44.06$, and -- most importantly -- ability by familiarity, $\underline{F}(1,52) = 6.54$, $\underline{p} < .01$.

Decomposing the effects, as expected, the higher ability students were generally more likely to spell the words correctly than were the lower ability students; familiar and predictable words were more likely to be spelled correctly than unfamiliar and unpredictable words, respectively; unfamiliar, unpredictable words were least likely of the four types of words to be spelled correctly; and average ability spellers in both classes spelled a greater proportion of familiar words correctly ($\underline{M} = .71$) than unfamiliar words ($\underline{M} = .55$), whereas the below average ability spellers were less affected by familiarity ($\underline{M}$ proportion familiar words correct = .44, $\underline{M}$ unfamiliar = .39). Again, the lack of interaction between class and ability points to a developmental lag interpretation of the spelling difficulty; the performance of below average RD fifth graders is comparable to that of below average regular class children and the performance of the average RDs is like that of the average regular class children.

Correlations

Correlational analyses, relating underlying cognitive processes to spelling ability were performed for the combined below average spelling ability groups and for the combined average ability spelling groups; this pooling is justified given the strong ability group similarities across classes and allows for somewhat more stable coefficients to be obtained. The correlations between the different measures and performance on the computerized spelling test are found in Table 4.

Strong correlations were found between the two spelling tests, demonstrating validity of the spelling test assessment. Spelling test performance was also correlated with the Schonell test, indicating that the phonological processing picked up by the word reading test (or some other component such as general experience with words) is important for spelling. This relationship accounts for much more variance in spelling performance for the below average group (66%) than for the average group (18%); this is likely the result of the below average group relying more heavily during spelling on the phonological skills, word experience, and etc. abilities that are tapped by the word reading task.

With the exception of the negative correlation between spelling and memory for designs for the below average spelling group, however, no other significant correlations between the hypothesized underlying cognitive processes and spelling were obtained. Indeed, the sign of the one statistically significant correlation indicates that the relation is in the opposite direction from what was expected; poorer performance on memory for designs, the measure of simultaneous processing, is correlated with better performance by the below average group on the computerized spelling test. Thus, in terms of providing support for the developmental lag hypothesis, only phonological processing, as

tapped by the Schonell, seems to be related to spelling within each ability group.

We are somewhat uncertain about how to interpret these results. Most certainly, the auditory serial recall (successive processing) task suffers from a severely restricted range; spans ranged from a low of 4 to a high of 6 words. Performance on the memory span task was also restricted, ranging from 3 to 6 letters. On the other hand, analysis of serial recall of items, in an attempt to stretch the measures out a bit, does not result in a substantial improvement in the correlations.

Both ability groups were combined ($n = 56$) in order to examine the relationships between overall spelling ability and the measures of underlying cognitive processing. This analysis of the overall relationships revealed a marginally significant correlation between single letter naming time and spelling test performance, $r = -.22$, $p < .07$, and a stronger relationship between naming time for letter pairs and spelling, $r = -.38$, $p < .05$. High positive correlations with spelling test performance were again obtained for the spelling achievement and word decoding tasks, $r = .73$, $p < .05$, for each measure.

Summary of the Cognitive Processing Results

Combining the group differences and correlational findings, the results do not provide terrifically strong evidence for either the developmental lag or developmental difference hypothesis. Poorer spellers are slower at naming letters than better spellers; the combined total group (but not individual ability groups) correlations between these measures and spelling supports the notion that lexical access may be a source of individual differences in spelling ability. On the other hand, the word decoding measure demonstrated both group ability differences and group correlations, indicating that

phonological processing may be a point at which poor spellers may lag behind good spellers.

Neither group differences nor correlations (with the exception of the one unexpected correlation with memory for designs obtained for the below average ability group) were obtained with the memory span or information integration tasks. Either the tasks do not represent sources of differences or lags within these groups or the measures were not sufficiently sensitive to pick them out.

These weak and possibly questionable results with the cognitive processing measures demonstrate the need to devise another method for understanding spelling as well as its development and differences. It seems that generally in psychological research, the cognitive correlates approach -- like the one used here -- yields confusing and/or conflicting findings (cf. Keating, List, & Merriman, 1985). An alternative approach has been to decompose a particular task and examine the components that lead to successful performance on the task. Thus, we examined the (mis)spelling of the individual words on the computerized spelling test in order to look at class and ability related differences in spelling as a function of word familiarity and spelling predictability.

Developmental Analysis of Spelling Errors

Misspelled words on the computerized spelling test were analyzed according to the developmental framework outlined before. Table 5 shows examples of how the words were scored. Precommunicative spellings (o for hospital) consisted of a letter or series of letters that are unrelated to the sounds in the word, and seem to indicate that the speller has no or very little idea of how to represent the phonetic representation of the word as graphemic letters. Semiphonetic spellings (chtpl) included initial and/or final portions of the word (generally just consonants), indicating some attempt to relate letter

names to the spelling of the word. Phonetic spellings (hosptl, hosbitel) included spellings in which each sound was represented by a letter or combination of letters, indicating analysis of the word according to phonological or spelling-sound correspondence rules. Finally, morphemic spellings (hospetal) represented misspellings occurring because of the misapplication of some learned spelling rule or generalization of the spelling of some known morpheme into a new word (such as petal in hospetal).

The labels for the classification system comes from Ehri (1985) with the modification of dividing phonetic spellings into a lower level of phonetic spelling, phonetic(1), in which each sound is exactly represented by an individual letter, and a higher level of phonetic spelling, phonetic(2), in which phonemes are represented by letter combinations. In addition, misspellings could be classified as typographical errors (nihgt for night), unrecognizable errors (, for often), or the wrong word (nine for garden); these three types of errors represented less than 2% of the data and were not included in the analyses.

The first two authors scored the errors; reliability was initially 91%. The majority of the scoring inconsistencies came from classification of words as phonetic(1) versus phonetic(2) for a few of the words (most notably president and often); combining these two classifications resulted in reliability of over 96%. Because of the difficulty we had in agreeing on phonetic(1) and phonetic(2) categories, these categories are combined in the analyses reported here. In addition, only a very few instances of precommunicative forms of spelling were observed so we combined the precommunicative and semiphonetic categories for the analyses. These combinations resulted in the analysis of precommunicative-semiphonetic, phonetic, and morphemic spelling errors as a function of word familiarity and

spelling predictability.

Table 6 contains the proportions of errors made by each of the four groups, classified into the three spelling categories, where pc-sp stands for the precommunicative-semiphonetic category, p for phonetic, and m for morphemic. To provide for greater stability of the proportions, word types were collapsed into an examination of familiar (n = 15) versus unfamiliar (n = 15) words, and of predictable (n = 22) versus unpredictable (n = 8) spellings. Proportion of errors combined across all word types (n = 30 words) is also shown. Chi-square tests were used to examine differences in distributions of spelling errors.

Looking first at the overall error classifications (as shown in the bottom of Table 6), the RD below average spellers produced statistically significantly different proportions of errors than either average group, $X^2(4) = 19.28$ and 11.22, $p < .05$, for the RD and regular class groups, respectively, but had a similar distribution of errors compared with their regular class below average spelling peers. Phonetic errors predominated in all four groups. However, in general, the average ability spellers made relatively more morphemic errors and fewer phonetic errors compared with the below average spellers, indicating that higher ability spellers are somewhat more reliant on learned spelling rules than lower ability spellers.

Although both groups of RD spellers were somewhat more likely to make phonetic errors on unfamiliar words than they were on familiar words, these differences are not significant. Across all groups, there is no statistically significant effect of word familiarity on the types of spelling errors that are made. Although the group differences indicate that familiar words were more likely to be spelled correctly than unfamiliar words and the better spellers were more likely to show a correctness effect as a function of familiarity,

this familiarity factor does not affect the type of error that is made. If we can infer spelling strategies from type of error, then this result indicates that, although RD children appear to be somewhat more likely to apply phonetic strategies to unfamiliar words, there are no significant differences in spelling strategies when attempting to spell familiar versus unfamiliar words.

There is, however, an effect of spelling predictability on type of error. For all groups, there is a tendency to make a greater proportion of phonetic errors on "easy" or phonetically predictable words than on unpredictable words. This tendency is statistically significant only for the regular class below average spellers, however, $\underline{X}^2(4) = 12.64$, $\underline{p} < .05$, and is marginal for the regular class average ability spellers, $\underline{X}^2(4) = 9.46$, $\underline{p} < .07$. The RD below average spellers don't really demonstrate this tendency to make more phonetic errors on predictable words but their overall proportion of phonetic errors (.70, with .69 for predictable words and .72 for unpredictable words) is already very high. This finding is consistent with the high correlation between the phonological processing measure and spelling performance.

A much clearer picture of spelling emerges from the examination of the spelling errors. Overall, the errors made by the average ability spellers indicate that they are at a higher level of spelling development than the below average ability spellers: Compared with the below average ability spellers, children in the average group spelled more words correctly and were more likely to be influenced in their performance by word familiarity and spelling predictability effects. When they did make mistakes, the better spellers made a relatively greater proportion of morphemic errors than the poorer spellers. Conversely, although all children made many phonetic errors, the lower ability spellers seemed to rely more heavily on phonetic strategies than the higher ability spellers, particularly when the spelling word had a predictable

spelling pattern.

In support of the developmental lag hypothesis of spelling ability, very few differences were obtained as a function of class. The regular class and RD average ability spellers produced very similar patterns of spelling errors and the RD below average spellers demonstrated just slightly more immature spelling patterns than the regular class below average spellers. These differences and similarities in patterns of spelling show up even in the absence of strong, reliable group differences or correlations with the theoretically underlying cognitive processes.

In addition, the patterns identified through the analysis of spelling errors provide better diagnostic and instructional information than the analysis of underlying cognitive processes. The lower ability spellers are relying heavily on phonological spelling strategies; most likely remedial instruction needs to emphasize nonphonetic spelling rules (e.g. the "long a" rule) and assistance in making the transition from phonological to morphological spelling strategies. These diagnostic and instructional implications are easily generalized to the classroom, whereas comments about differences in underlying cognitive processes such as lexical access speed are less easily generalized. On the other hand, if as Gerber and Hall (1987) argue, we can somehow develop more specific models of how cognitive processes relate to and aid spelling, both the analysis of cognitive processes and spelling errors can be communicated to the teacher faced with inculcating efficient spelling in the classroom. To this end, we would argue that further investigation into elementary cognitive processes of memory access and componential analysis of phonological processing represent the most fruitful avenues for research.

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Table 1

Tasks

Task	Measure Collected	Purpose
EPSB Spelling Achievement Test	raw score (max. = 45) percentile	ability matching
Schonell Word Reading	raw score (max. = 100)	decoding
Naming Time **- Single Letters** **- Letter Pairs**	median time median time	lexical access
Letter Memory Span	span (max. = 9)	memory span
Memory for Designs	raw score (max. = 77)	simultaneous processing
Auditory Serial Recall	span (max. = 7)	successive processing
Computerized Spelling Test	errors (max. = 30) type of error time to begin spelling time to complete spelling	examine spelling as a function of spelling predictability and word familiarity

Table 2

Means (and standard deviations)

Measure	Class: Regular Below (n = 18)	Class: Regular Average (n= 20)	Class: RD Below (n = 8)	Class: RD Average (n= 10)
EPSB Spelling Achievement Test	15.17 (4.55)	27.35 (3.65)	15.13 (4.70)	26.50* (5.80)
Schonell Word Reading	30.83 (5.59)	41.00 (7.00)	31.63 (6.78)	38.40* (6.31)
Naming Time - Single Letters	417.67 (80.15)	374.70 (77.73)	542.38 (167.67)	416.90* (45.46)
- Letter Pairs	1066.22 (184.21)	853.25 (148.90)	1155.63 (260.36)	886.20* (116.14)
Letter Memory Span	3.50 (.71)	3.80 (.83)	3.75 (.46)	3.40 (.70)
Memory for Designs	48.22 (12.22)	53.50 (8.36)	47.38 (8.96)	53.90 (8.01)
Auditory Serial Recall	4.44 (.51)	4.25 (.79)	4.38 (.74)	4.50 (.85)
Computerized Spelling Test	12.50 (4.77)	19.00 (4.96)	13.13 (4.64)	19.00* (3.53)

*Ability effect $p < .05$

Table 3

Means (and standard deviations) for proportion correctly spelled words as a function of familiarity and predictability

	Class			
	Regular		RD	
Word Type	Below	Average	Below	Average
Familar-Predictable	.48 (.22)	.77 (.17)	.48 (.23)	.77 (.17)
Familiar-Unpredictable	.33 (.21)	.56 (.24)	.38 (.23)	.60 (.21)
Unfamiliar-Predictable	.49 (.18)	.66 (.18)	.52 (.12)	.67 (.12)
Unfamiliar-Unpredictable	.10 (.17)	.25 (.26)	.17 (.19)	.23 (.22)

Table 4

Correlations with the computerized spelling test

Measure	Ability	
	Below (n = 26)	Average (n = 30)
EPSB Spelling Achievement	.61*	.45*
Schonell Word Reading	.81*	.42*
Naming Time		
- Single Letters	-.08	.05
- Letter Pairs	-.17	.05
Letter Memory Span	-.03	-.14
Memory For Designs	-.45*	-.17
Auditory Serial Recall	-.06	-.15

*p< .05

Table 5

Examples of spelling error classifications

	Classification			
Word	**Semiphonetic**	**Phonetic (1)**	**Phonetic (2)**	**Morphemic**
hospital	chtpl	hosptl hospdel hspitbl	hospedol hosbitel hostebol	hospitole hospetal hospitol
these	thit	thes	theys vize deaz	thees theas theese

Table 6

Distribution of errors across spelling categories

	Class											
	Regular						RD					
	Below Average						Below Average					
Word Type	pc-sp	p	m	pc-sp	p	m	pc-sp	p	m	pc-sp	p	m
Familiar	.10	.64	.26	.06	.61	.32	.20	.61	.20	.05	.44	.51
Unfamiliar	.05	.66	.29	.06	.58	.37	.09	.74	.13	.03	.61	.36
Predictable	.09	.68	.23	.09	.64	.27	.17	.69	.14	.05	.58	.37
Unpredictable	.02	.54	.44	.02	.54	.44	.09	.72	.19	.02	.49	.49
All words combined	.07	.65	.28	.06	.59	.35	.14	.70	.16	.04	.54	.42