A Comparison of the Spelling Errors of Older Dyslexic and Second-Grade Normal Children

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The spelling errors of dyslexic students have frequently been cited in the literature as qualitatively different from those of normal learners (Bannatyne, 1971; Critchley, 1975; Farnham-Diggory, 1978; Orton, 1937). Not only are spelling errors often regarded as diagnostic of dyslexia, but particular error patterns have been attributed to dyslexic subgroups (Boder, 1973; Camp and Dolcourt, 1977; Johnson and Myklebust, 1967; Nelson and Warrington, 1974). Specifically, the errors most commonly attributed to dyslexics are (a) those indicating poor audiophonic analysis, (b) letter order confusions, and (c) failure to recall "sight" vocabulary or the specific arrangement of letter sequences in words.

While some authors view "dysphonetic" spelling as symptomatic of a primary processing deficit in dyslexia involving auditory analysis (Boder, 1973; Ingram, Mason, and Blackburn, 1970), others have emphasized the close relationship between dysphonetic errors and generalized language dysfunction (Sweeney and Rourke, 1978; Nelson and Warrington, 1974). These studies, regardless of emphasis, however, share a psychoneurological view of dyslexia which attributes to underlying process dysfunctions the supposed differences in spelling error types, and which minimizes the importance of school instruction, intelligence, grade, age, and spelling achievement level on error patterns.

Some evidence exists that spelling error pattern differences may be more apparent than real. Both Holmes and Peper (1977) and Nelson (1980) compared normal and dyslexic spelling error types and found no differences in the characteristic errors of their subjects. The first study compared the spelling test performance of good and poor fifth-grade readers, but the study suffered from problems with subject selection and validity of the error analysis scheme. The second study (by Nelson) provides a more convincing base for reassessing common beliefs about spelling error significance.

Nelson recognized that spelling error patterns change according to developmental level and achievement, and chose achievement-level peers as the appropriate comparison group for her dyslexic population.

Thirty dyslexic students compared to younger normal students spelling at an equivalent level were found to make errors that were no different in frequency in any of the three categories of interest: phonetic accuracy, serial order, and orthographic legality. In both groups, the incidence of letter order and orthographically illegal errors was low and the majority of spellings were phonetically accurate.

The present investigation of spelling error differences, like Nelson's, assumed that the appropriate comparison group for the dyslexics would be younger children spelling at an equivalent level. Since learning to spell involves the formulation and application of spelling principles which are progressively altered and refined as a function of experience with written language (Bissex, 1980; Henderson and Beers, 1980; Read, 1975), it seemed likely that a significant proportion of errors in the spellings of dyslexic children could be explained in terms of normal psycholinguistic developmental processes. Specifically, it appeared important to account for the frequency of errors generated on the basis of preconventional or "invented" spelling principles (Beers and Henderson, 1977; Chomsky, 1979; Read, 1971), and to view the incidence and type of these errors in older dyslexics in relation to those made by younger children who had achieved the same level of skill.

The study examined qualitative differences between the spelling error types of normal second graders and older dyslexic children, using a method of analysis that sought to differentiate phonetically accurate errors following "invented" or preconventional spelling principles from those which conformed to conventional sound-symbol correspondence rules of English. Thus, while phonetic accuracy or inaccuracy in spelling was a variable of interest, error classification was influenced by apparent developmental level of the errors (Gentry, 1978; Gerber and Hall, 1980).

The major hypothesis tested was as follows: When spelling achievement level is controlled, the spelling of older dyslexic and normally achieving second-grade students will not differ significantly in (a) proportion of serial order errors to total errors, (b) proportion of phonetically accurate errors (including preconventional and conventional types) to total errors, and (c) proportion of preconventional spelling errors to phonetically accurate errors. Additional questions addressed in the study concerned the effects of verbal intelligence, age, and time in an Orton-Gillingham program on phonetic spelling ability, and differences in graphomotor speed and accuracy between the groups.

Method

Twenty-seven dyslexic subjects and 27 normal second graders were included in the study. Twenty-one dyslexics were drawn from a private

school for dyslexic children[1] and six from several public schools in Vermont. They met the following criteria: average intelligence (WISC-R VIQ and FSIQ above 89; mean FSIQ for group 103); grade placement between 4th and 8th; severe discrepancy between intellectual ability and reading achievement (2-year lag or more); and spelling grade placement between 2.6 and 3.6 on the Stanford Dictated Spelling Test (Appendix A). The second graders were selected from four Vermont public schools and met the following criteria; teacher ratings of average achievement, no history of retention or special education assistance, and grade scores of 2.6-3.7 on the Stanford Dictated Spelling Test in April of their second-grade year. Twenty-six subjects in each group were male. The groups did not differ significantly on mean spelling achievement or Peabody Picture Vocabulary Test-Revised standard score.

Words for error analysis were obtained from the 15 or more errors that occurred as each child took a 50-word Stanford Dictated Spelling Test. The test consists of 40 words at the 2nd-grade level and an additional 10 words at the 3rd-grade level. The test battery included measures of word recognition, vocabulary, and graphomotor speed and accuracy as well.

The method of error analysis was designed to classify errors by phonetic accuracy, developmental level, and specific type. Each phoneme of each misspelled word was scored. Correctly spelled phonemes were not tallied or classified. Graphemes that corresponded to no phoneme were classified as phonetically inaccurate, along with serial order errors, omissions, and unconventional substitutions. In cases where syllables or parts of syllables were represented with one letter, all the phonemes included in the syllable were scored. Thus, in the case of DRSR (dresser), where the "S" represents both a vowel and a consonant phoneme, the spelling error would be scored as two preconventional misspellings (category IC2 below).

Error Types[2]

I. Preconventional Phonetically Accurate Errors
   A. Preconventional Consonant Errors
      1. Nasal omitted before final stop consonant (WED/wind).
      2. *D* spelling for tongue flap /D/ occurring in middle of word (LIDL/little).
      3. Use of a letter whose name contains the sound of the phoneme, especially Y for /w/ and H for /c/ (YOH/watch).

[1]The author wishes to express her deep appreciation to the staff and children of the Carroll School in Lincoln, Mass., and the Vermont schools that participated in this study.

[2]More detailed presentations of the rationales behind the selection of these error types can be found in the dissertation on which this paper is based (Moats, 1982).

4. Representation of affrication of initial blends *tr* and *dr* (JRSR/dresser; CHRAN/train).
5. Other articulatory phonetic detail (USZE/use).

B. Preconventional Vowel Errors, Phonetically Accurate
1. Vowel letter whose name represents the long vowel and representation of r-controlled long vowels with short vowels paired with them in articulation (MAK/make; WER/wear).
2. Letter name segmented and used to represent lax (short) vowel sound (BAD/bed; GIT/got).
3. Representation of glide, rounding, or elongation of long vowel (TIY/tie).
4. Transitional preconventional vowel spellings (WAER/wear; TIUR/tire).

C. Syllabic Phonetically Accurate Preconventional Spellings
1. Letters *m, n, r, l* used syllabically (LITTL/little; RITN/written.
2. Letter name for syllable or part of syllable BGAN/began; DRSR/dresser).

D. Phonetic Spelling of Morpheme *Ed* (CARD/cared).

II. Phonetically Accurate Conventional Errors

A. Consonant Errors
1. Consonant doubling; unnecessary addition of a doubled letter.
2. Consonant doubling; omission of a doubled letter.
3. Alternative consonant grapheme for phoneme, within the symbol system.
   a) Conforming to constraints of position (WHER/wear).
   b) Violating position constraints (CKARD/cared).
   c) Omission of silent letter in *knew* and *written*.

B. Vowel Errors
1. a) Vowel grapheme greater than 10 percent predictable according to sound-symbol and position constraints (LODE/load).
   b) Vowel grapheme less than 10 percent predictable but still permissible (TROBEL/trouble).
   c) Vowel misspelling derived by analogy to known word rather than by use of a spelling pattern (YOUSE/use).
2. Reduced vowel (schwa) substitution (LESSEN/lesson).

C. Syllabic alternative *el* for *le* (in *trouble* and *little*).

III. Phonetically Inaccurate Errors

A. Consonant Nonphonetic
1. Consonant omission (STUCK/struck).
2. Consonant addition (BEGAND/began).
3. Consonant substitution.

a) Voiced-voiceless confusion (CLASS/glass).
b) Preservation of salient phonetic feature (PLUN/plum).
c) Bizarre substitutions (EVEY/easy).

B. Vowel Nonphonetic
1. Vowel not represented, or omitted.
2. Vowel addition (BEGANE/began).
3. Vowel substitution.
a) Similar phonetic features (NOW/knew).
b) Not similar (NEN/noon).

C. Serial Order Errors
1. Letter order confusions (SRTUK/struck).
2. Duplication and insertion of letter out of sequences (see LeCours, 1966) as in CAREERED/cared.

Fifteen misspelled words from each subject, selected by rank order of error frequency on the second-grade spelling sample, were analyzed for frequency of spelling error types. Scoring was done blind and was repeated to ensure reliability and agreement. Vowel errors were the most difficult to score reliably.

A variety of planned statistical analyses and informal *post hoc* analyses were performed on the data.

Summary of Results

The spelling of the older dyslexic and younger normal achievers, equated on spelling achievement, did not differ significantly in phonetic accuracy, level of maturity, or incidence of serial order confusion (Table I). Furthermore, the range of individual variation on these spelling error variables was highly similar in the two groups. The large majority of both groups were phonetically accurate spellers, in that their misspellings were plausible renderings of the sounds in words 70 percent of the time or more, with mean phonetic spelling ratios (based on preconventional and conventional error types) exceeding 80 percent in both groups. The proportion of letter order errors (2 percent in the dyslexic and 4 percent in the second-grade groups) was low for each group. These findings correspond closely to those of Nelson (1980) who also studied children equated on spelling achievement.

Some differences between groups were found on measures of graphomotor fluency and control. Second graders as a group were slower on a copying task, but more dyslexic children made copying errors, and more dyslexic children had observable difficulties with letter formation in handwriting. The graphomotor measures were moderately correlated with each other in the dyslexic group, but not in the second graders. WISC-R Coding, copying speed, and spelling achievement tended to

Table I[3]
Numbers and Proportions of Spelling Errors for Dyslexic and Normal Subjects, by Group; Numbers of Subjects Making Each Error and Maximum Errors per Subject

Error Type	Dyslexic (N=27)				2nd Graders (N=27)			
Preconventional Phonetically Accurate	No.	Prop.	S's Making Error	Max. Error Per Sub.	No.	Prop.	S's Making Error	Max. Error Per Sub.
IA1 nasal omitted	0	.00	0	0	0	.00	0	0
IA2 *d* for /D/	2	.003	2	1	2	.003	2	1
IA3 letter name	2	.003	2	1	0	.00	0	0
IA4 affrication *tr, dr*	0	.00	0	0	4	.006	4	1
IA5 phonetic detail	0	.00	0	0	1	.001	1	1
IB1 letter name, long	43	.065	20	5	47	.069	24	4
IB2 letter name, short	2	.003	2	1	11	.016	8	2
IB3 glide, rounding	7	.01	6	2	4	.006	4	1
IB4 transitional	28	.043	19	3	28	.041	20	2
IC1 syllabic *l, m, r,*	32	.049	10	6	49	.072	11	9
IC2 syl.,letter name	12	.018	5	2	4	.006	2	2
ID *ed* morpheme	18	.027	17	2	14	.02	13	2
Subtotal	146	.222			164	.240		

[3]NOTE: "A" errors are consonant phoneme errors; "B" errors are vowel phoneme errors; and "C" errors are those involving syllables or parts of syllables (two phonemes).

Table I—continued

Error Type	Dyslexic (N=27)				2nd Graders (N=27)			
Conventional Phonetically Accurate	No.	Prop.	S's Making Error	Max. Error Per Sub.	No.	Prop.	S's Making Error	Max. Error Per Sub.
IIA1 doubling, add.	9	.014	5	4	12	.018	12	1
IIA2 doubling, om.	74	.112	25	5	85	.125	25	5
IIA3a substitution, c.	17	.026	15	2	10	.015	10	1
IIA3b sub., rule viol.	21	.032	13	3	26	.038	18	3
IIA3c om. silent let.	50	.076	27	2	46	.067	27	2
IIB1a substitution, v.	87	.13	27	7	68	.099	27	5
IIB1b sub., low prob.	36	.055	20	3	35	.051	20	3
IIB1c by analogy	14	.021	14	1	11	.016	10	2
IIB1c schwa	67	.102	27	5	72	.106	26	5
IIC syllabic el	28	.043	10	4	20	.029	9	4
Subtotal	403	.613			385	.565		
Total Phonetically Acc.	549	.836			549	.805		

Table I—continued

Error Type	Dyslexic (N=27)				2nd Graders (N=27)			
Phonetically Inaccurate	No.	Prop.	S's Making Error	Max. Error Per Sub.	No.	Prop.	S's Making Error	Max. Error Per Sub.
IIIA1 omission	22	.033	14	3	43	.063	23	6
IIIA2 addition	10	.015	9	2	3	.004	3	1
IIIA3a voiced/voiceless	7	.010	7	1	2	.003	2	1
IIIA3b same sound class	6	.009	6	1	2	.003	2	1
IIIA3c bizzare sub.	10	.015	8	2	6	.009	6	1
IIIB1 omission, v.	3	.005	3	1	6	.009	5	2
IIIB2 addition,v.	10	.015	6	3	7	.010	7	1
IIIB3a similar sub.	11	.016	10	2	20	.029	15	2
IIIB3b dissimilar sub.	16	.024	11	2	17	.025	12	2
IIIC1 letter order	8	.012	8	1	17	.025	12	3
IIIC2 insertion (serial order)	5	.008	4	2	10	.015	7	3
Subtotal	108	.164			133	.195		
Grand Total	657	.99			682	1.000		

vary together, with poor graphomotor skills correlating with lower spelling achievement.

There was no evidence that subgroups of dysphonetic or dyseidetic spellers existed in greater numbers in the dyslexic group than in the normal second graders, using the author's method of spelling error analysis and subgroup classification. These descriptors could have been applied to several members of each group.

Based on the presence of a combination of symptoms (letter formation errors, slow copying and slow Coding), there were four dyslexic and no second-grade subjects who could be labeled "dysgraphic."

Preconventional spelling errors were more frequent in number in the second graders, but the difference in preconventional phonetic spelling ratio (PCPSR) was not statistically significant (Table II). The groups were highly similar as far as the stages of development represented in their misspelling. In the second graders and the dyslexics, preconventional phonetic spelling ratio was correlated with achievement, with immature strategies more common in the lower achievers spelling at a late second-grade rather than an early third-grade level.

Evidence was obtained through regression analysis that duration of exposure to an Orton-Gillingham based instructional program does account for a moderate proportion of the variation (.19) in phonetic spelling accuracy in the dyslexic group, who had spent between seven months and three years in remedial training. A similar analysis could not be conducted on the second graders' data, because it was not known exactly what kind of instruction had constituted their educational experience.

Table II

Anova for Differences in Phonetic Spelling Ratio (PSR) and Preconventional Phonetic Spelling Ratio (PCPSR) for Dyslexics and Second Graders, Based on Proportions for Individual Subjects

		Dyslexic	Second Graders
PSR	Mean	.84	.81
	SD	.11	.10
	Range	.52–1.0	.43–1.0
$F(1,52) = 1.46$ (ns)			
PCPSR	Mean	.26	.28
	SD	.10	.14
	Range	.05–.46	.00–.60
$F(1,52) = .308$ (ns)			

However, the breakdown of phonetic spelling ratio (PSR) by school revealed that the mean PSR's for the second-grade subjects by school ranged from .74 to .86. Again, the differences between these four second-grade groups were not statistically significant, but this range may indicate that in the second graders some of the variance in phonetic spelling ability might be attributable to instruction.

Post hoc analysis of the misspellings for each word made by the individuals of each group suggested the presence of some subtle differences between the groups not evident in the planned statistical analyses. Some of the test words elicited more errors in one group than another. Perusal and comparison of these words and others, indicated that if the dyslexics did differ from the second graders in spelling ability, they were somewhat more knowledgeable of spelling rules and constraints and somewhat better at phonemic segmentation. The second graders' ability to spell the words *tie, why,* and *little* more accurately than the dyslexic group may possibly indicate that the younger children had better specific word memories for high frequency, familiar words.

A *post hoc* reliability study on the dyslexic group data suggested that although the phonetic accuracy and level of maturity of the group's spelling did not change over a six-week period, the qualitative aspects of the errors of individuals were subject to some random variation, and were influenced by unknown factors in addition to strategy preference and processing strengths.

Discussion

The outcome of this study offers no support for prevailing diagnostic and classification approaches to dyslexia that characterize the majority of children as phonetically inaccurate spellers. Not only were the dyslexic children as a group very good at phonetic spelling, but they were on the average as competent as second graders spelling at the same level. The high phonetic spelling ratios were found in public and private school dyslexics and in each group of second-grade subjects from four different schools. How, then, might the results of this study be reconciled with others that have found dyslexics to be phonetically inaccurate?

First, it is possible that because of the exclusion of dyslexic children with low verbal IQ's and low FSIQ's from the study, the language disordered subgroup of dyslexics (Denckla, 1979; Mattis, French, and Rapin, 1975) was not well represented in the sample. Since phonetically inaccurate spelling has been linked with language disorders by some investigators (Nelson and Warrington, 1974; Sweeney and Rourke, 1978), it is possible that others who have classified dyslexics as "phonetically inaccurate" have based the observation on a group of children with generalized language deficits. The predominance of phonetically accu-

rate spelling in the average IQ subjects of the present study suggests that phonetically inaccurate spelling may be a symptom of generalized language learning impairment rather than a descriptive characteristic of reading and spelling disability. Phonetically accurate spelling appears to be characteristic not only of children with limited, specific spelling problems (Naidoo, 1972; Frith, 1980), but also of reading and spelling disabled children without generalized language dysfunction, such as the present group, who have attained a late second or early third-grade spelling level with the aid of special instruction.

Second, it is possible that the achievement range of these subjects was superior to those of other studies which have found phonetically inaccurate spelling in dyslexia. It is known that children slow to acquire reading skills are also slower to attain the prerequisite level of phonological awareness necessary for reading. Thus, if dyslexic children at ages eight to ten are included in a sample (e.g., Boder, 1973) and they have achieved less than a second-grade level of spelling and reading skill, their spelling efforts may appear to be "dysphonetic" in that speech sounds are not well represented. The use of this descriptor, however, may falsely imply that a structural and/or functional deficiency in the auditory analytic aspect of spelling is causally related to the learning disability and is an enduring characteristic of the learner. The present study indicates that for most dyslexics who have achieved a mid-second to mid-third grade spelling level, the auditory analytic function as reflected in phonetic spelling accuracy, has improved with age and instruction to a level commensurate with that of younger normal children at the second-grade level.

Third, the methods of spelling error analysis used in studies characterizing young dyslexics as "dysphonetic" may have been insensitive to the preconventional phonetic spelling strategies characteristic of beginning spellers, and misclassified some errors as phonetically inaccurate. Particularly in cases (e.g., Camp and McCabe, 1977) where surface characteristics such as omissions, additions, and substitutions of letters are scored as phonetically inaccurate without the child's perspective on the alphabetic symbol system and its relationship to phonetic features being taken into account, the scoring could be misleading. This study used a very detailed, phoneme-based approach to analysis of errors which is more sensitive to phonetic accuracy than the whole-word methods which have been used by other investigators. Many misspellings in this analysis were judged as phonetically accurate (but preconventional), such as letter name spellings and syllabic spellings, that violate the literate adult's conception of phonetic accuracy. Since approximately one quarter of the phonetically accurate errors in both groups studied were preconventional, the sensitivity of a scoring system to early strategies in spelling development could easily influence the study results.

The failure of this study to corroborate the predominance of dysphonetic spellers in the reading disabled population is based on analysis of spelling errors only, and thus cannot be taken as counter-evidence for the "dysphonetic" reading styles noted by Boder (1973), Camp and Dolcourt (1977), and others. "Dysphonetic" reading styles have been documented by these investigators with measures of phonic decoding fluency and accuracy. The reading measure employed in this investigation was not sensitive to word reading strategies or response latencies, and the sensitivity of the measure (recognition of the words also used for the spelling test) was restricted by its low ceiling—most subjects could read most of the words. On unknown words, there might well have been significant differences in the response latencies of the two groups and relative accuracy and fluency of their decoding efforts, but this was not recorded. Lack of fluency in phonic application may characterize the reading performance of many dyslexics, although they can spell phonetically—a discrepancy explainable by virtue of the fact that reading and spelling are not inverse processes and that they are to some degree cognitively disconnected (Bryant and Bradley, 1980; Cronell, 1978; Frith, 1980).

The present study also failed to support the prevalent notion that serial order errors are characteristic of the writing of dyslexics, and that they occur more frequently there than in the writing of normals. It is possible that some dyslexics do indeed commit a striking number of order errors (e.g., LeCours, 1966) and the present study of 27 subjects simply failed to include an example of this subtype. Denckla (1979) suggests that "sequencing" disability is a low-incidence phenomenon (2 percent among the learning disabled), but her classification is not based on documented differences in spelling errors. A plausible explanation for the contradiction between the present findings and the attention that order errors receive in the literature may also be that any order errors occurring in an older student appear noteworthy according to expectations based on age. If spelling achievement level is used as the basis for comparison, however, order errors occur with about the same frequency in the dyslexic population as in the second graders to whom they were compared.

The proportions of preconventional and transitional spellings across the groups also yielded no statistically significant differences in the frequency with which preconventional strategies were employed; the developmental stages of the dyslexic misspellings generally paralleled those of the normal second graders. Nevertheless, inspection of the specific misspelled words did suggest that the dyslexic children were selectively more mature or better informed about spelling conventions than their second-grade counterparts. For example, the dyslexics made fewer errors of consonant omission, particularly in consonant blends and clusters, and made fewer "syllabic ending" errors. They made no affrication of *tr* and *dr* errors, and they knew better the rule that governs the

spelling of *bigger*. No instances were noted of specific words eliciting spellings from the second graders that were better informed by rules than those of the dyslexics; some words, however, were better spelled by rote. No support is provided here for the notion that dyslexic children may rely on surface correspondences and letter-name strategies longer than is appropriate for their achievement age (Henderson, 1980); nor was there evidence that "transitional" errors (defined by Gerber and Hall, 1980, as those which occur when graphic constraints are beginning to be taken into account by a phonetic speller) are more prevalent in the dyslexics. Whether preconventional strategies may persist in the spelling of dyslexics at higher levels of achievement (above grade 4) is still undetermined.

The issue of dyslexic subgroups and the possibility that spelling errors may distinguish subtypes was also addressed in the analysis. A wide range of individual variation on the phonetic spelling continuum was present in both the dyslexic and second-grade groups, and the distributions of scores on PSR for each group were highly similar. A few children in each group met the statistically defined criteria for "dysphonetic" and "dyseidetic" spelling error patterns. Essentially, the approach to spelling error analysis used in this study—one that is phonemically based rather than word-based, and one that quantifies phonetic spelling accuracy through the construction of a ratio—does not appear to identify subtypes that are unique to the dyslexic population, as they occurred in the second graders as well. Baron (1979) has noted that Boder's subtypes occur in normally achieving children; to the extent that the present method of analysis overlaps with Boder's identification procedure, these results suggest that in both normal and poor achievers who have attained a second-grade level of proficiency, there will be some children who are over-reliant on a phonological encoding strategy and have trouble remembering what words look like ("dyseidetic") and some who are markedly poor at rendering a phonetic equivalent of an unknown word ("dysphonetic"). Qualitative aspects of spelling errors that implicate processing strengths and weaknesses may help distinguish subgroups of children, especially if additional neuropsychological diagnostic measures are employed, but these subgroup characteristics may describe groups of average achievers as well as poor achievers.

The only dependent variables that could be interpreted as identifying a subgroup unique to the dyslexics were those related to the transcription or writing process. Dysgraphia is described by Johnson and Myklebust (1967) as a specific disturbance in visual-motor integration and the ability to image, remember, and execute a motor plan. This dysfunction results in poor copying ability and letter formation errors. Analogous specific impairments are documented in cases of acquired writing disturbances in adults (Kinsbourne and Rosenfield, 1974; Luria, 1966; Marcie and Hecaen, 1979) in whom the many components of written language can

potentially be selectively affected by brain damage. In the present study, four dyslexic subjects were uniformly poor at copying, letter formation, and WISC-R Coding, but there was no observable relationship between the presence of these symptoms and the specific types of spelling errors made. Within the larger dyslexic group, however, slow copying was characteristic of the lower achievers. The low but significant correlations between copying, Coding, and spelling achievement must be interpreted only tentatively as indicators that graphomotor dysfunction might be a direct handicapping factor in learning to spell. Certainly the development of graphomotor fluency and its relationship to spelling merit further investigation.

The dyslexic group was strikingly poor at WISC-R Coding when scaled scores (based on chronological-age norms) were compared to the second graders. The finding agrees with previous WISC-R studies by Bannatyne (1974), Kaufman (1975), and others, documenting a tendency for LD groups to score low on that subtest. As Kaufman (1981) discusses, however, we have not as yet determined whether this phenomenon is best interpreted as symbolic learning, memory, attention-concentration, or sequential processing deficiency, or some combination of these factors. The overlap between what the test measures and what learning to read and spell demand appears to be considerable. The correlation between Coding and copying speed in the dyslexic group may have resulted from one or more of the common task components, including "speed of symbolic processing" and the major praxis component. The specific contribution of the motor expressive task component to reduced skill at Coding and copying needs to be tested far more rigorously before any conclusion about the relationship between graphomotor fluency and spelling can be drawn.

Spelling Disability in Dyslexia

A Theoretical Context

Given the absence of evidence in the spelling of dyslexics that phonological or sequential processing deficits characterize the disorder, or that dyslexics progress through the early stages of development in a different manner (other than more slowly), the results of the study seem compatible with information processing theories of spelling which suggest that our capacity for remembering and recalling visually coded images for words is a critical component of spelling competence.

Sloboda (1980) in a series of controlled experiments with proficient adult spellers, demonstrated that good spellers have easily accessible visual specifications for words in memory; they remember and can retrieve exactly what letters are in a word, and use this information effectively in lexical decision tasks. Less good spellers, on the other hand,

tend to store information about phonemes and thus are more easily confused by phonologically similar alternatives in lexical decision tasks. Sloboda concludes that people who spell well, although they do know the rules governing spelling, probably do not know how to spell by virtue of these rules; they spell well by a rote memory process.

Farnham-Diggory and Simon (1975) demonstrated a similar phenomenon in normal fourth-grade children. Under experimental conditions, fourth graders remembered word spellings after a purely visual presentation better than after a purely auditory presentation of the letter sequences; visual presentation of a meaningful word seemed to provide these normal spellers with information that was retainable over an interpolated task that was not available after auditory presentation of the word. Simon and Simon (1973) demonstrated that normal fourth graders could spell unknown words more accurately than the Hanna, Hanna, Hodges, and Rudorf (1966) algorithm that was based on a computerized analysis of phoneme-grapheme correspondences. The Simons postulated that mechanisms other than those represented by the algorithm must be at work in the spelling productions of normal children. They hypothesized that the speller generates a possible "list" of spellings for an unknown word, based on phoneme-grapheme, orthographic pattern, morphological, and sometimes syntactic information (as in homophones representing different parts of speech) and compares this list with whatever information about the word's visual representation exists in storage. The completeness of the visual representation is established primarily through exposure in reading and is influenced by the speller's ability to construct and retain visual images of words (Farnham-Diggory and Simon, 1975). In the normal learner, the list of spelling possibilities for unknown words is matched with partial word memories and tested for accuracy.

This "generation and test" phase of spelling figures heavily in Simon's (1976) task analysis of the spelling process, which posits that a complete visual representation is accessed directly, associated with a written word habit and expressed in a "rote" fashion or presumably without the devotion of conscious attention. Phonetic misspellings, which are characteristic of normal spellers, and apparently dyslexics, are permutations from the lists of admissible correspondences and rule-based grapheme strings generated in the absence of a complete visual representation.

The dyslexic students in this sample could, for the most part, generate permissible grapheme strings for the given words. However, reliance on the correspondences and spelling rules that they have learned is not sufficient for them to spell ambiguous words (such as those with reduced vowels) or unpredictable words. Their failure to establish rote access to a visual, and perhaps motor, word store leaves them dependent on spelling by sound and spelling by rule.

Other investigators (Kagan and Moore, 1981; Seymour and Porpodas, 1980; Vellutino, 1979, 1980) have shown that the "visual" deficits of most dyslexic children are specific to the storage and retrieval of grapheme strings, and dyslexic children are not accurately described as having modality-specific "perceptual" deficits. Vellutino's (1980) theory of dyslexia is appealing in light of the present data; he proposes that weak links in the verbal-visual association process, or an inefficiency in verbal-visual cross-referencing, specific to processing words, may impair the recognition, storage, and retrieval of graphemic patterns.

Conclusions

The results of this study have implications for research, clinical diagnosis, and instruction.

Those who are engaged in the study of reading and spelling disorders are cautioned to consider the extent to which perceived or measured differences in the spelling errors and spelling strategies of dyslexic students are simply a function of the subjects' level of spelling achievement. Unless aspects of written encoding are interpreted in light of normal developmental shifts in skill and strategy, comparisons of dyslexics and their chronological age peers have little explanatory value as far as shedding light on the nature of the disability or identifying unique characteristics of the reading and spelling disabled population.

For a number of reasons, subgroup classification of dyslexics based on spelling errors alone would appear to be an ill-founded practice. The qualitative aspects of spelling errors are not extremely reliable in any individual's spelling performance. Phonetic spelling ability is not independent of the child's instructional history, and appears to be a function of achievement level and verbal intelligence. Furthermore, other studies have indicated that a child's approach to spelling may not be analogous to his approach to word recognition. A more judicious approach to the subgroup issue at this point may be to examine the relationship between spelling and reading error types and a whole battery of valid neuropsychological measures, taking into account the child's age, achievement, IQ, and past instruction.

Because the same range of variation in spelling styles and skills was found in both dyslexics and second graders, diagnostic-prescriptive teaching methods should be appropriate for both groups—all kinds of children, not just the learning disabled. Although dyslexics in general need to be taught in a more carefully structured manner, any child who is deficient in phonetic representation might benefit from additional work in that component of the spelling process.

The majority of the dyslexic subjects had been taught by a synthetic phonics and spelling rule approach, and the positive effects of the instruction were certainly apparent in their spelling errors. Most of these children were severely retarded in their rate of spelling achievement,

however, perhaps because they were "stuck" with a spelling strategy that is inadequate for perfect word recall. Teaching children rules and correspondences may constitute one essential component of early spelling instruction, but other approaches designed to enhance specific rote, recall of words may be needed to take children beyond "sounding out." These would include emphasis on word derivation, meaning, and structure (Chomsky, 1970), and multisensory whole word study techniques (Fernald, 1943).

There are many issues raised by this investigative effort that could be addressed by future work. Replication of the study at both an earlier and later stage of spelling development would be desirable. The qualitative differences between groups suggested by the *post hoc* analyses here might be brought into sharper focus with a word list selected to elicit certain error types, for example words with consonant clusters, syllabic endings, and long vowels with low probability spellings, and words with affixes spelled by rule.

Current investigations of dyslexic subgroupings, after classifying subjects according to a valid test battery, might investigate further whether a constellation of neuropsychological symptoms does correspond to spelling and reading error propensities independent of instruction and achievement level. The absence of support for unique dyslexic subgroups in this study of spelling errors may be contradicted by one that is able to measure a much wider range of abilities, including reading error tendencies.

Graphomotor development should be studied to illuminate the role that transcription plays in learning to spell. Criterion tasks of graphomotor fluency need to be developed that are sensitive and reliable before adequate research can be conducted.

And finally, single subject case studies are needed so that the effects of different kinds of practice on learning to spell can be measured in dyslexics with well defined characteristics. This research at least served to show that many foregone conclusions about dyslexia need continuing, rigorous questioning if our approaches to assessment and treatment are going to advance.

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Appendix A

Stanford Dictated Spelling Test, Form E

Word	Frequency*	Predictability**	Word	Frequency	Predictability
the	1	P	paper	1	P
can	1	P	nap	4	P
she	1	UP	start	1	P
hat	1	P	never	1	P
play	1	P	why	1	P
up	1	P	glass	1	P
are	1	UP	pass	1	P
ball	1	P	bit	1	UP
cup	1	UP	dresser	5	(P)
little	1	P	began	1	P
wind	1	P	use	1	P
hay	3	P	tire	1	P
card	2	P	lesson	2	UP
black	1	P	load	2	P
band	2	P	easy	1	P
them	1	P	knew	1	UP
fell	1	P	plum	4	P
noon	2	P	cared	1	P
bear	1	UP	wear	1	UP
snowing	1	P	bigger	1	P
mine	1	P	fullest	1	NL
show	1	P	struck	2	UP
forget	1	P	captain	1	UP
trouble	1	UP	loose	2	UP
tie	1	UP	written	1	UP

*Frequency according to Lorge-Thorndike estimates:
1 = 100 or more occurrences per million running words
2 = 99-50 occurrences per million running words
3 = 49-30 occurrences per million running words
4 = 29-10 occurrences per million running words
5 = 9-1 occurrences per million running words

**P = word predictable in the Hanna et. al. (1966) analysis of phoneme-grapheme correspondences.

UP = word unpredictable using phoneme-grapheme rules alone.

NL = not listed.

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