Visual and phonological determinants of misreadings in a transparent orthography

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ABSTRACT: Growth of word reading skills was examined in first and second year Italian school children by analysis of the pattern of reading errors. The study was designed to investigate the role of visual vs phonological similarities as causes of misreadings in a transparent orthography. The selection of reading material was tailored to permit a meaningful cross-language comparison with pre-existing findings on English-speaking children. The results showed that, in Italian as in English, spatially-related errors (such as confusing *b* and *d*) constituted a minor proportion of the total errors. Errors on vowel and consonant letters that are not spatially confusable accounted for the greater proportion of the total. Moreover, the co-occurrence of spatial and phonological confusability resulted in appreciably more errors than when either occurred without the other. Vowel position in the syllable had no systematic effect on errors. In beginning readers of Italian, consonant errors outnumbered vowel errors by a wide margin; the reverse pattern was found in previous studies on English-speaking children at the same level of schooling. It is proposed that differences between Italian and English in the phonological structure of the lexicon and in the consistency of grapheme-phoneme correspondences account in large part for the differences in quantity and distribution of the errors.

KEY WORDS: Beginning readers, Cross-language, Error analysis, Misreading, Reversals

INTRODUCTION

Unlike the acquisition of spoken language, which develops in the normal child merely through immersion in a speaking environment, learning to read can be a frustrating enterprise for many children. Extracting the linguistic message from seemingly bizarre scribbles may appear to the beginning reader to be an unnatural act (Gough & Hillinger 1980; Vellutino 1987). Learning to read in an alphabetic system demands abilities that do not develop automatically from experience with the spoken language. These include: (1) apprehending the letters and their serial arrangement; (2) abstracting the (morphophonemic) units of the linguistic code to which the letter combinations correspond (3) accessing the appropriate lexical representations; (4) integrating the results of orthographic decoding with syntactically-driven parsing operations (Byrne 1992; Gleitman & Rozin 1977; Liberman, Shankweiler & Liberman 1989; Stanovich 1985). Mastery of these skills requires prolonged instruction and much practice. In view of the special cognitive requirements of reading, it is

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understandable that many children fail to master and coordinate all the necessary skills. We might expect that a deficiency of a particular skill would be reflected in the kinds of misreadings that occur. Thus, misreadings can be diagnostic of the sources of difficulties.

In most early research on the dyslexic child, developmental dyslexia was viewed as a disorder of the visual aspects of reading (Hinshelwood 1917). Accordingly, the visuo-spatial properties of letters and words were stressed in contrast to their linguistic functions. A special source of difficulty, on this view, was attributed to the potential right-to-left reversibility of some letter sequences and to the confusability of letters of similar shape which differ in orientation, such as *b-d*, *p-q*, *u-n* (Orton 1925, 1937).

An unfortunate shortcoming of discussions of reversal errors in the literature is that reversals have been reported selectively in isolation from other aspects of the error pattern. When these errors are viewed in the context of the totality of misreadings, their relative importance tends to diminish. In a study by Liberman and her colleagues, letter confusion and reversal of sequence were found to account for only a small proportion of the errors in oral reading even among very poor readers (Liberman, Shankweiler, Orlando, Harris & Bell-Berti 1971; see also: Fischer, Liberman & Shankweiler 1978; Shankweiler & Liberman 1972; Werker, Bryson & Wassenberg 1989). Moreover, developmental studies have shown that reversal errors are not peculiar to children with reading difficulties, but can be detected during the normal development of reading skill (Gibson, Gibson, Pick & Osser 1962). Finally, there is no clear indication that children who at an early stage tend to confuse letters of similar shape are more likely to remain poor readers than those who do not (Simner 1982; Mann, Tobin & Wilson 1987).

Nonetheless, errors prompted by visual confusability do undoubtedly occur in some children who lag behind in reading. Thus, a possible role for visual confusions as a factor contributing to reading difficulties cannot be dismissed. No research study to date has fully disentangled the relative contribution, and possible interactions, of visual perceptual factors, on the one hand, and linguistic and orthographic factors on the other. The approach we adopt, which, oddly, has apparently not been exploited, is to systematically compare the error pattern in reading the same items presented in upper and lower case script. Since some of the letters, notably the reversible ones, have different shapes in the two scripts, we can directly measure the effects of visual similarity (i.e., reversibility) on frequency of misreading. That was one of the purposes of the present study.

Cross-language variations

Given that earlier research strongly implicates the importance of the non-spatial, linguistic-phonological aspects of the reading process in determining the misreadings that occur, the present study was also designed to identify those aspects of the error pattern that may vary across languages. It has been

found, in fact, that the error patterns of beginning readers of English differentially reflect the phonological class of the misread segment and its position within the syllable (Shankweiler & Liberman 1972). Our point of departure was a discrepancy in the error rate on consonants and vowels. Children learning to read English have consistently shown a higher proportion of errors on vowels than on consonants (Bryson & Werker 1989; Fischer et al. 1978; Fowler, Liberman & Shankweiler 1977; Liberman et al. 1971). This effect of category could reflect phonological differences between the two classes of segments and/or differences in the relative difficulty of the spellings of consonants and vowels (Shankweiler & Liberman 1972).[1]

Analysis of errors with phonologically-controlled materials has also uncovered effects of the position of the target segment within the word: Consonants in the final position of monosyllabic words (and nonwords) are generally more frequently misread than consonants in initial position (Fowler et al. 1977; Liberman et al. 1971). In contrast, the placement of a vowel within the syllable – whether it was the initial, medial or final segment – had no effect on the frequency with which it was misread. It was noted by Fowler et al. (1977) that consonant errors bore a close phonetic relationship to their target phonemes (reflected in distinctive feature similarity), while vowel errors were apparently unrelated to their targets by phonetic feature.

It is significant that the greater propensity to err on vowels may be language-specific, however. For beginning readers of Serbo-Croatian, it has been found that relatively few decoding errors occur, especially among vowels (Ognjenovic, Lukatela, Feldman & Turvey 1983). This finding would fit with the transparency of the orthography of Serbo-Croatian, but, alternatively, it may reflect the paucity of vowels in Serbo-Croatian. In regard to the error rates for consonants in syllable-initial and syllable-final position, however, the findings in Serbo-Croatian were consistent with English: Reading final consonants turned out to be less accurate than initial ones.

The work of Ognjenovic et al. illustrates that cross-language comparison can reveal differences and similarities in the error pattern that may have significance for identifying the sources of the problems of learning to read (see Liberman, Liberman, Mattingly & Shankweiler 1980). Languages that exploit the alphabetic principle vary as to the particular sublexical features that are most directly reflected in word spellings. In some it is almost invariably the phonemic structure that is captured; other orthographies do as English does, often giving representation to the morphophonemes (Chomsky & Halle 1968; Venezky 1970). Owing to the special characteristics of English orthography, especially the propensity to represent morphological structure, the error pattern of children learning to read English may differ significantly from that of beginning readers of languages in which the mode of orthographic representation is more narrowly phonological. Yet up to the present time, a disproportionate share of the research on children's reading problems, including error analyses, has been confined to readers of English. We should not necessarily expect the results of these studies to provide a trustworthy map

of the course of learning to read in an orthography that maps rather differently. In this study we focus on one such language, Italian.

Structural differences between Italian and English: Consequences for the beginning reader

Spoken Italian has fewer vowels than English, seven in stressed position and only five in unstressed (Ferrero, Magno-Caldognetto, Vagges & Lavagnoli 1978). Moreover, in regard to their acoustic spectra, Italian vowels are highly distinct and nonoverlapping in formant frequencies. Spoken English, on the other hand, has a dozen or more vowels, since the seven basic vowel nuclei are significantly modified by the presence of an off glide (Agard & Di Pietro 1965). Central vowels in English (General American Dialect) show spectral overlap, especially in their reduced form (Peterson & Barney 1952).

Italian has a relatively shallow phonology, with relatively little morphophonological alternation in comparison to English. In addition, though Italian has a mixed stock of syllable types, it has fewer than half as many different types as English (Carlson, Elenius, Granstrom & Hunnicut 1985). Moreover, unlike English, which has a predominantly close-syllable structure (e.g., CVC, CVCC, CCVC, etc.), Italian's most frequent syllable form is the open syllable (in sequences such as CVCVC, CVCV, CCVCV, etc.) with relatively few variations (Carlson et al. 1985).

The Italian orthography displays a high degree of transparency, since the alphabetic rendition of the language is based on an almost biunivocal correspondence between grapheme and phoneme. Thus, each of the five vowel letters has only one phonologic rendition in Italian regardless of the context in which it occurs. Similarly, each phoneme generally has an invariant orthographic representation.[2]

English, on the contrary, is represented by a deep orthography. English spellings tend to preserve the complex system of morphophonemic alternations in the language (Chomsky & Halle 1968). However, no matter how well the orthography of English may comport with the morphological intuitions of the literate user, it would exact a cost from the beginner. Thus, some English spellings (e.g., HEAL-HEALTH) indicate shared morphemes at the expense of consistency in rendering phonological structure.

Having outlined potentially relevant structural differences between the English and Italian languages and their corresponding orthographies, we should indicate expected cross-language differences and similarities in the error pattern of beginning readers: (1) The error pattern should differ across languages with respect to the relative difficulty of vowels and consonants. Thus, we would expect that, in contrast to English, vowels in Italian would be less often misread than consonants, given their limited number and straightforward orthographic rendition; (2) On the other hand, given that both Italian and English use nearly the same set of alphabetic characters we would expect that visual-spatial difficulties based on letter confusability, to the extent that they occur, would not vary across the two languages.

In a previous cross-language study of phonological segmentation in Italian-speaking and English-speaking children (Cossu, Shankweiler, Liberman, Katz & Tola 1988), we showed that Italian preschool children were able to profit from the simpler syllable structure of their language in performing a meta-linguistic task. They proved to be more proficient than their American counterparts in analyzing both the syllabic and phonemic structure of spoken words. Up until now, however, there has been no systematic comparison of the error pattern in beginning readers of the two languages. The present research examined reading errors by Italian children using phonetically and orthographically-controlled materials. The findings were compared to previous findings in English-speaking children by Liberman et al. (1971).

Using the methods and results of Liberman et al. (1971) as a point of departure, we attempted to reconstruct as closely as possible the tasks and experimental procedures with Italian children. We examined Italian children with respect to: (1) the relative frequencies of visuo-spatial vs. phonological confusions; (2) the distribution of reading errors within the word; (3) the comparative error rate on vowel and consonant segments.

Two experiments were carried out: in the first, the test words were chosen to represent the principal spelling patterns of consonants and vowels in Italian, and to present maximal opportunities for spatial confusions among the reversible consonants, *b, d, g, p, q*. In the second experiment, non-words were created to permit the investigation of errors in relation to position of the vowel within the syllable. Each test list was presented in both upper and lower case.

EXPERIMENT 1

Experiment 1 was designed to address two issues: (a) the role of visuo-spatial vs. phonological factors in reading errors; (b) a cross-language comparison between a transparent and a deep orthography. In order to match as closely as possible the conditions of previous studies with English-speaking children (Liberman et al. 1971), a list of 60 words was selected from first and second year reading vocabularies (see Appendix 1). Because of the peculiarities of each language, it was not possible to reproduce all the characteristics of the test words of the earlier study. For example, the material prepared by Liberman et al. (1971) distinguished between sight words, non-sight words and word-forming reversals. In Italian, by contrast, neither the sight-word-non-sight word distinction can be made, nor is it possible to create more than a few reversible letter strings that form a different word when read from right to left.

Method

The Italian subjects were 70 school children (35 males and 35 females) randomly selected from first and second year classes of an elementary school in the northern Italian city of Parma. We restricted our selection to the earliest

school years, because pilot work had shown that by the end of the second school year most Italian children make very few errors in decoding. In the school selected for our study, reading is taught eclectically. None of the children experienced anything approximating a pure phonic or a pure whole-word approach. All children with known or suspected history of brain damage were excluded from the experimental sample, as well as those children with clinically-evident language impairment, visual or auditory deficits, or behavioral disorders. As shown in Table 1, all the children were within the normal range of intelligence, according to the Verbal Scale of the WISC.

Table 1. Mean age and IQ of Italian school children

Group	Age (months) Mean	IQ (WISC verbal) Mean
Year 1 (n = 35)	82.03 (75–87)	102.06 (81–129)
Year 2 (n = 35)	94.28 (90–98)	109.09 (80–134)

We adopted the following criteria for the Italian materials: (1) all the words were bisyllabic; (2) the list included each of the 15 Italian consonants (in a CV sequence); (3) each consonant appeared twice in the first syllable and twice in the second one, for a total of 60 words. The list included 44 CVCV words; in 16 cases, however, (due to the limitations of children's vocabularies) we were forced to include CCV sequences in the non-critical syllable (appended to the CV sequence of the target).

In order to examine the role of spatial features of the letter set, the same word list was presented twice, once in upper case and once in lower case. The interval between the two testing sessions was one week and the order of presentation for the upper vs. the lower case list was counterbalanced. Each word was printed on a separate index card in upper and lower case. The cards for each list were placed face down in front of the subject and were turned over one by one by the examiner. The children were asked to read each word as it was presented and to give their best guess if they were unsure. They were tested individually during the middle of the school year. Their responses were recorded on magnetic tape and phonetically transcribed by the examiner.

The findings from the Italian-speaking subjects were compared with data from English-speaking beginning readers from the USA who had been studied using the same methods of investigation by two of the authors (see Liberman et al. 1971 for details). Although the two samples are as similar as was practically attainable demographically, in type of school and in the instructional approach taken to reading, it is patent that such matching can only be approximate. Within these constraints, there were differences in the criteria by which subjects were selected. The American children (n = 18) constituted the lower third of a second year elementary school population defined by score on the experimental word reading test. The Italian sample, as noted, was a random selection from first and second year students in the targeted schools.

These differences in selection procedure do not permit unequivocal quantitative comparisons across national groups. However, in view of the fact that many aspects of the error pattern in English-speaking learners have been shown to be quite stable across wide differences in level of attainment, it is reasonable to assume that valid comparisons can be made regarding the relative frequencies of different categories of misreadings (see Fowler et al. 1977; Shankweiler & Liberman 1972).

Scoring of reading errors was based on the following criteria:

1. Reversal of Sequence (RS) was scored when a word, or part of a word was read from right to left (e.g.: *palo*, as 'aplo', 'olap' or 'lopa').
2. Reversal of Orientation (RO) was scored when *b*, *d*, *p*, *q* and *g* were mutually confused. In order to check the effect of visual vs phonological factors, the same criteria were adopted for the scoring of these letters in upper case.
3. Consonant Errors (CE), unless otherwise specified, comprise all the errors on consonants, other than the RO category. Consonant substitution, deletion, or insertion were therefore included under this head.
4. Vowel Errors (VE), included all vowel substitutions, deletions or insertions.
5. Complex Errors (CXE) were scored when more than two errors occurred in one word. (e.g., when cinque /tʒinkwe/ [five] was read as /kina/).

Results

The number of phonemic segments misread in the 60-item word list was tallied for each subject. In the first year, errors per subject averaged 9.1 for upper case and 12.5 for lower case. In the second year, the corresponding means are 3.4 and 4.4, respectively. As expected, second year students made fewer errors on the reading test than first year students. In each year, words printed in lower case characters turned out to be slightly more difficult to read than those in upper case. The low rate of errors, even in first year children, testifies to the rapid acquisition of decoding skills in Italian beginning readers. With regard to the qualitative aspects of the error pattern, Figure 1 shows the distribution of errors among the error categories for years one and two combined. In this figure, RO error rates are given also for the upper case counterparts of the reversible letters though these, of course, are not reversible. On inspection of Figure 1 we note that consonant errors other than reversals (CE) together with vowel errors (VE) accounted for the bulk of the errors, whereas the proportions of RS, RO and complex errors (CXE) are comparatively low. Two findings stand out: first, consonant errors predominate over vowel errors (a point to which we return in the discussion). Second, within each error category (other than RO errors) the difference between the error rates engendered by upper and lower case is small.

An analysis of variance was carried out in which errors from all categories (total error) was the dependent variable and year in school and letter case were

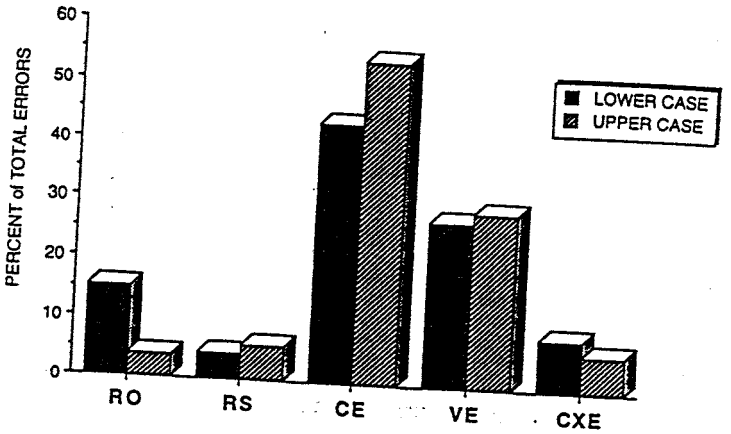

Figure 1. Mean percent of reading errors in upper and lower case tabulated by category for 1st and 2nd year Italian school children (percentages computed separately by case). *Category of errors*: RO – reversal of orientation; RS – reversal of sequence; CE – consonant errors; VE – vowel errors; CXE – complex errors.

the independent variables. School year [$F(1,32) = 9.27$; $p < 0.003$] and letter case [$F(1,32) = 16.51$; $p < 0.0001$] are each significant factors, together with their interaction [$F(1,32) = 5.20$; $p < 0.03$]. Though it was absolutely small, the significant effect of case, and the significant interaction confirms that lower case presentation was indeed somewhat more difficult for the first year students.

The effect of spatial reversibility. Mean frequencies of errors by category and corresponding percentages based on opportunities are presented in Table 2. As for letter reversal errors, the table shows that these are almost entirely confined to the first-year children. Right-to-left readings of whole words (RS errors) occurred infrequently even among the younger children.

In order to probe the influence of letter case on confusability, we rank-ordered the 60 words of the test list according to frequency of RO error, separately for upper and lower case, for first and second year students. The rank order of difficulty for words presented in each case agrees closely, although lower case presentation elicited more errors in 54 of the 60 words. A rank correlation analysis shows that upper- and lower-case performance is significantly correlated in both the first and second year ($\rho = 0.73$; $z = 7.14$; $p < 0.0001$ and $\rho = 0.53$; $z = 4.50$; $p < 0.0001$, respectively).

Since there was a small excess of errors in the lower case format, we conducted a further analysis by category to locate the source of the discrepancy. For this analysis, we subdivided the nonreversible consonant errors (the CE category) into errors of substitution (CE1) and errors of addition and deletion (CE2). A Wilcoxon test was carried out for each subcategory of errors, separately for first and second year groups, to evaluate the significance of each difference. At each school year, there were significantly more lower-case

Table 2. Frequencies of error by category for upper and lower case and percentages (in parentheses) of opportunities [in brackets]

	First year		Second year	
	Upper	Lower	Upper	Lower
RO				
Reversal of Orientation [n = 1260]	16 (1.26)	74 (5.87)	1 (0.08)	17 (1.35)
RS				
Reversal of Sequence [n = 2100]	11 (0.52)	13 (0.61)	15 (0.71)	13 (0.62)
CE 1				
Consonant Substituion [n = 4200]	93 (2.21)	101 (2.40)	31 (0.74)	47 (1.12)
CE 2				
Consonant Addition and Deletion [n = 4200]	84 (2.0)	85 (2.02)	31 (0.74)	27 (0.64)
VE				
Vowel Errors [n = 4200]	90 (2.14)	124 (2.95)	39 (0.93)	40 (0.95)
CXE				
Complex errors [n = 2100]	25 (1.19)	43 (1.02)	3 (0.14)	10 (0.48)

than upper-case errors in the set *b*, *d*, *g*, *p*, *q* (first year, $p < 0.001$; second $p < 0.03$). As expected, the largest discrepancy between upper- and lower-case emerged for the RO subcategory. In the combined sample, RO errors accounted for 15.3% of the total, whereas the equivalent set in upper case (which are not spatially confusable) yields only 3.8% of errors.

It is worth noting that within the set of spatially confusable consonant characters, there are correlated phonological similarities. For example, all are stops that share distinctive features in common. In view of this, it is not surprising that *b* was often misread for *d* (36 times), since the phonemes /b/ and /d/ share all their features except place of production. Similar examples can be cited for upper case characters, where *G* was misread for *C* 16 times. However, *u* was never misread for *n* and the reverse happened only once, in spite of their figural resemblance. Yet, two letters showing little visual similarity, but high phonological similarity (*d* and *t*) were confused 11 times in lower case and 11 times in upper case. Thus, though spatial similarity may contribute to reading difficulties for beginners, it is not sufficient by itself to elicit reading errors. With the exception of vowel errors in year 1 (where lower case errors were also more frequent; $p < 0.03$), no other difference attributable to case reached significance. Thus, the excess of errors on lower case is chiefly attributable to the letters *b*, *d*, *p*, *g* and *q*. The pattern of errors on this set is also notably different in lower cases and upper cases. In lower case,

the error entailed a confusion within the set on 85% of presentations; on only 15% was a reversible target letter misread as a nonreversible letter. By contrast, in upper-case presentation of the corresponding letters there were few confusions within the set. In order to display the pattern of confusions among the reversible lower-case consonants, the data were arrayed in a confusion matrix. Only the data for the first year children are presented because so few errors occurred during the second year. As shown in Table 3, there is scant tendency for reciprocity in confusions between members of reversible letter pairs. For example, in the first year *b* is misread for d *36* times while *d* is misread for *b* only eight times. Asymmetry is also found for *q*, which is misread 13 times as *p*, whereas *p* is never misread as *q*.

Table 4 shows correlations among the error categories, aggregated over subjects, for year 1 and year 2 Italian children combined. It is notable that word reversal errors (RS) are uncorrelated with reversal errors that involve individual letters (RO). The latter, on the other hand, tend to co-occur with errors that are clearly nonspatial. Thus, there seems to be no justification for the common practice of grouping the RS and RO together. Lack of association between RO and RS was also noted in the study of reading errors in American school children by Liberman et al. (1971). The cardinal importance of language-related factors in misreadings is clearly evident when we examine the role that phonological category plays in the error pattern.

Table 3. Matrix of confusion among reversible lower case consonants for first and second school years combined

		Substitution				
		b	*d*	*g*	*p*	*q*
Target	*b*	–	36	3	3	0
	d	8	–	2	1	0
	g	0	0	–	0	0
	p	4	1	0	–	0
	q	0	0	4	13	–

Table 4. Correlations among categories of reading errors in combined Italian groups

	RS	RO	CE	VE
RS		−0.04 $p < 0.36$	0.20 $p < 0.04$*	0.27 $p < 0.01$*
RO			0.60 $p < 0.001$*	0.49 $p < 0.001$*
CE				0.65 $p < 0.001$*
VE				

Cross-language comparison. Strictly speaking, we cannot make a direct comparison on *quantity* of errors between the present findings on Italian children and those of Liberman et al. (1971) on English-speaking children. Differences in the criteria for subject selection, and the impossibility of equating the instructional content in the two countries mean that the consistently lower error rates in the Italian children cannot be given an unequivocal interpretation. Notwithstanding this, great care was exercised in creating the test materials in this study so as to provide a comparable frame for comparison of the *distribution* of errors in relation to letter-case and phonological category.

In order to support our assumption that the distribution of errors within the word does not depend crucially on the level of ability, we compared the Italian good and poor readers from the first and second school years. For this comparison we selected the reading list from experiment 2 (the 'vowel reading test'), since it was made up of monosyllables, and thus resembled, in so far as possible with Italian materials the list presented to the American children. Moreover, we reasoned that nonwords, more likely than real words, would evoke qualitative differences in the reading strategies of reader groups differing in ability level if such differences existed.

Error rates were ranked for Italian children in the first and second school year in both upper- and lower-case reading conditions. The nine best and poorest readers were selected from each school class. The mean error rate in the first year was 4.4 (SD = 3.2) for poor readers and 0.4 (SD = 1.01) for good readers. In the second school year, the corresponding means were 2.1 (SD = 1.36) for poor readers and 0.11 (SD = 0.33) for good readers. The results were submitted to a four-way ANOVA with two between (grade and reading ability) and two within factors (letter case and position of vowel). As expected, grade [$F(1,32) = 11.92$; $p < 0.002$] and reading level [$F(1,32) = 39.57$; $p < 0.001$] were significant, as well as their interaction [$F(1,32) = 9.74$; $p < 0.004$]. The effect of letter case was nonsignificant, as was the grade by letter-case interaction, the reading-level by letter-case interaction, and the grade by reading-level by letter-case interaction. In addition, the vowel position factor was nonsignificant as well as the related interactions: grade-by-position, reading-level by position and grade by reading level by position.

The analysis revealed that overall error patterns did not differ across ability levels. Neither letter case nor vowel position was treated in a qualitatively different way by good and poor readers. Thus, the results of this analysis suggest that the reading strategies adopted by average beginning readers and older poor readers were essentially the same, in agreement with findings on English-speaking readers who differed in ability level (cf. Fowler et al. 1977; Bryson & Werker 1989). Therefore, we have established an acceptable level of comparability between the Italian and American samples, although an exact comparison is not possible.

In Figure 2, we show the distribution of errors among the four categories as proportions of total error for the first year Italian sample and the American second year poor readers. First, letter reversals (RO) account for a similar

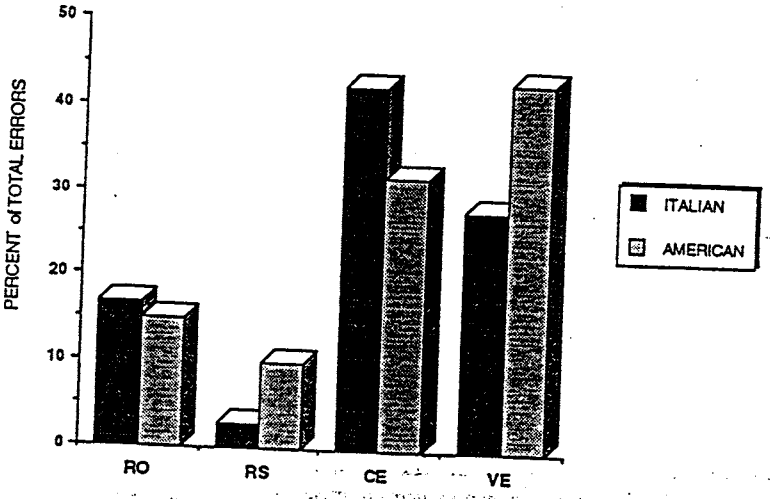

Figure 2. Comparison of reading errors in lower case according to category in 1st year Italian and 2nd year English-speaking children: Percentages of total error. *Category of errors*: RO – reversal of orientation; RS – reversal of sequence; CE – consonant errors; VE – vowel errors.

proportion of the total error in each group (17% for Italians and 15% for Americans). The confusions among the reversible letters are presented in Table 5 in the form of a confusion matrix which includes the data for both the Italian and American samples.

Both groups confined their errors on the set *b*, *d*, *p*, *q*, *g*, chiefly to confusion among *b*, *d* and *p*. The one notable difference is that the American children, but not the Italians, tended to reverse in each direction, i.e., vertically (e.g., *b*, *p* and *p*, *b*) as well as horizontally. In neither language group does the distribution of responses conform to the relative frequencies of occurrence of these letters in samples of text (in the case of English, we used

Table 5. Confusions among reversible letters in American and Italian children (percentages based on opportunities)

		Obtained *b*	*d*	*p*	*g*	
Presented	*b*		10.2 14.2	13.7 1.2	0.3 1.2	A I
	d	10.1 3.2		1.7 0	0.3 0.8	A I
	p	9.1 1.2	0.4 0.3		0.7 0	A I
	g	1.3 0	1.3 0	1.3 0		A I

A = American (data taken from Liberman et al. 1971); I = Italian.

published tables by Mayzner & Tresselt 1965; for Italian, we made our own letter count). Right-to-left sequence reversals (RS) occur very infrequently in Italian, probably because they rarely form meaningful words. Nonreversible consonant and vowel errors together account for most of the total error in both language groups, but the relative frequencies are reversed in the two samples, being nearly mirror images of one another. The Italians, unlike the English-speaking learners, but like the Serbo-Croatian beginning readers, misread consonants more often than vowels.

EXPERIMENT 2

The purpose of Experiment 2 was to test for the effect on reading errors of varying the position of the vowel within the syllable. Because the Italian language has predominantly an open-syllable structure, its lexicon contains relatively few monosyllabic words with syllable-final consonants. Therefore, nonwords are required to make a satisfactory test for the effect of position of a target vowel letter.

Method

A list of monosyllabic nonwords was made, each comprising a vowel and two consonants. Each of the five vowels appeared twice in each position (initial, medial and final) for a total of 30 nonwords (see Appendix 2). These materials were presented to the same groups of Italian first- and second-year students who served as subjects in Experiment 1. As in Experiment 1, upper-case and lower-case forms were prepared. These were presented one week apart in counterbalanced order. The child's task was to read each nonword aloud. Errors were tallied on both consonants and vowels. Furthermore, errors were classified according to the position of the vowel (initial, medial, final) within the word, and the type case (upper/lower). However, no attempt was made to assess the effect of position of the consonant because relatively few words in the lexicon of Italian contain closed syllables.

Results

As expected, children from the second school year outperformed the younger group in reading the monosyllabic nonwords [$F(1,32) = 11.92$; $p < 0.002$]. The effect of case in this experiment did not approach significance in either first or second year students. Therefore, we pooled the data for upper and lower case: the first year students misread a mean of 9.4 segments per subject and the second year students misread 3.6 per subject. Comparing these results with those of Experiment 1, we find that the error rates for nonwords and real words are similar.

Of central interest is the discrepancy between vowel and consonant errors.

With nonwords, as with words (Experiment 1), vowel reading was more accurate than consonant reading. By examining the percent of errors as a function of opportunities (Table 6), we see that at both age levels and in both upper and lower case, vowels represent a lower proportion of the total error than consonants. Indeed, vowel errors occurred at a rate of well under 1% among the second year students. Possible reasons for the discrepancies between the language groups in the relative frequency of vowel and consonant errors are considered in the following discussion.

Table 6. Frequencies of errors percentaged as a function of opportunities on vowels in nonwords

School year	Case	Consonants (n = 2100)	Vowels (n = 1050)
1st	Upper	135 (6.4%)	37 (3.5%)
	Lower	130 (6.2%)	27 (2.6%)
2nd	Upper	46 (2.1%)	3 (0.2%)
	Lower	69 (3.2%)	8 (90.7%)

The test of the effect of position of the vowel within the syllable yielded a null result for the combined school years. That is, when the vowel was placed in initial, medial and final position within the syllable, the errors did not vary in any systematic way. In this respect, the data agree with findings on English-speaking children for both words (Fowler et al. 1977; Liberman et al. 1971) and nonwords (Bryson & Werker 1989).

GENERAL DISCUSSION

In discussing the findings of the two experiments, we consider first the data on beginning readers of Italian and then interpret the findings in relation to existing data on beginning readers of English and other languages. First, with regard to quantity of misreadings, Italian beginning readers made strikingly few decoding errors, especially after the first year at school. Secondly, within each category of errors except RO, the difference between the error rate in upper and lower case is minimal. It is apparent, however, that within the subset of spatially-reversible characters (*b*, *d*, *p*, *q*, *g*), visual similarity does contribute to reading difficulties for beginners, indicated by the significant excess of errors on these consonants in lower case. The frequencies of these errors diminished greatly in the second year, but the effect of case remains significant. Thirdly, the greater proportion of the total error is attributable to non-reversible consonant letters and vowel letters. Thus, with the exception of the reversible consonant set noted above, the error pattern reflects not the spatial characteristics of the misread letters but their functions within the linguistic system and its orthographic manifestation.

In the case of the spatially-reversible consonants, it is notable that

reversibility is not ordinarily sufficient by itself to elicit reading errors. Scrutiny of the confusions shows that only when visual similarity is associated with phonological similarity of the corresponding phoneme (as in the case of *b* and *d*, where these letters ordinarily represent phonemes that differ by only one distinctive feature) were misreadings apt to occur. In a like fashion, a low degree of phonological similarity can forestall misreadings even when high visual confusability exists (e.g., *u* and *n*, and *F* and *E* are rarely confused). Moreover, even when a letter pair presents good figural contrast, high phonological similarity (e.g., *d* and *t*) may lead to a high rate of confusions. Further examination of the confusions reveals that the matrix of substitution errors was similar in both upper and lower case. In upper case, substitutions were more likely to occur when minimal phonetic distance is combined with visual confusability. Thus, in the first and second year combined, *G* is misread for *C* 17 times, whereas *L*, *E* and *F* were never confused. But *D* was misread for *T* 11 times, while *B* was never misread for *R*, or vice versa. Similarly, in lower-case presentation, *z* was misread for *s* seven times, due to the fact that these letters represent a phonetically-similar segment by means of a visually-similar shape. Visual similarity alone is clearly not sufficient to elicit substitution errors, as evident from the absence of substitution errors between the vowel *u* and the consonant *n*. Hence, the two sources of similarity, though they interact, produce unequal effects: Phonological similarity tends to override visual similarity.

Taken together, these findings confirm the indications of previous studies of beginning readers of English in pointing to the central relevance of language-related structural (phonological and morphological) factors in reading acquisition, with visuo-spatial factors being relegated to a relatively minor role[3] (Fowler et al. 1977; Liberman et al. 1971; Shankweiler & Liberman 1972).

The distribution of errors in beginning readers of Italian reflects the phonological structure of Italian and the transparent orthography that renders it. Thus, as expected, some aspects of the error pattern contrast with what has been found in readers of English. For example, the small number of vowels in Italian, their non-overlapping acoustic spectra and the fact that each tends to be consistently represented by the same letter – all cooperate to minimize the occurrence of vowel errors. Similarly, the greater number of consonants in Italian (relative to English), and the complexities of their orthographic rendition in some cases together may account for the preponderance of consonant errors in Italian. For both upper and lower case, consonant errors exceeded vowel errors by a wide margin.

The stability of the excess of consonant errors (relative to vowel errors) in Italian children's misreadings is confirmed by the results of Experiment 2, which provides an independent demonstration of this pattern with non-word test materials. Here, too, the findings on the Italian children contrast strikingly with those of their English-speaking peers: Vowel errors as a function of opportunity constitute a low proportion of the total.

In comparing misreadings of Italian-speaking and English-speaking beginning readers, we find both similarities and differences. In each orthography, visual-spatial confusability of characters is of roughly the same magnitude as measured by their proportions of the total error. But when we examine errors as percentages of opportunities for error of each kind, a different picture emerges: letter reversals loom larger in relation to non-spatial errors in the Italian children, whereas in English-speaking beginning readers, the reverse is true. This is not because reversal errors are absolutely more frequent in Italian than in English. Indeed, they are less frequent, but their importance seems greater because other errors are comparatively fewer. As for sequence errors, in both the Italian and American beginning readers, right-to-left sequence reversals (RS) occur relatively infrequently. Sequence reversals amount to 4.3% and 10% of the total in the Italian and the American children, respectively. As we noted, their lower rate of occurrence in Italian probably reflects the paucity of reversible words in that language.

The study was not intended to yield a direct comparison between American and Italian groups with regard to quantity of errors, but it is impossible not to be impressed by the disparities in this regard, though interpretation must be tempered by the differences between the two studies in subject selection. Notwithstanding that, the results showed that the first-year Italian children, though a year younger and exposed to half as much schooling, were much more accurate, making far fewer errors (as a function of opportunity) than the American children. These findings are compatible with the inference that the orthographies of Italian and English pose somewhat different problems for a beginning reader. The Italian children appear to master the relevant decoding skills much more rapidly than their American age mates, as also suggested by findings of Cossu et al. (1988) and Lindgren, DeRenzi & Richman (1985).[4]

We have pointed to some cross-language differences that are surely relevant: the transparency of the Italian orthography, the relatively shallow phonology with fewer syllable types and morphophonological alternations, as well as the limited number of vowels, all of which are acoustically well-spaced. These characteristics would likely cooperate to minimize the obstacles for the Italian beginning reader. It is apparent that the structural differences between the two languages and their orthographies find expression in the contrasting patterns of consonant and vowel errors. A three-way comparison of error data among beginning readers of English, Serbo-Croatian and Italian is useful for elucidating the patterns. English and Serbo-Croatian, though sharing a closed syllable structure, differ in the size and complexity of the vowel set and in the structure of their orthographies. The Serbo-Croatian vowel set contains only five vowels, and, as in Italian, their acoustic spectra (formant frequencies) are distinct and nonoverlapping (Ognjenovic et al. 1983). In keeping with these phonological and phonetic differences, the orthographies of English and Serbo-Croatian also differ in the nature of the correspondences between letters and word structure: The Serbo-Croatian

orthography is highly phonographic, while English is more strongly morphologically influenced. It is significant that in the study of Ognjenovic et al., beginning readers of Serbo-Croatian, made fewer errors on vowels than on consonants, in contrast to their American counterparts, but like the Italians in the present study.[5]

Like English-speaking learners studied by Fowler et al. (1977), the Italians showed no significant position effect for vowels in Experiment 2. The further question of presence or absence of phonological similarity of the vowel substitutions could not be addressed in this study, however, because even the first-year Italian children made so few vowel errors that no analysis in terms of distinctive features could be carried out. As noted earlier, the open-syllable structure that prevails in Italian precludes a comparison of error rates on initial and final consonants. However, in both Serbo-Croatian and English, each of which has closed-syllable structure, the same position effect on consonants was observed: beginning readers misread more consonants in syllable-final position than in syllable-initial position (Ognjenovic et al. 1983).

Script systems in use in different languages display diverse means for adapting the alphabetic principle to the structural peculiarities of the language so as to minimize arbitrariness, redundancy and ambiguity (Klima 1972). The facts regarding their diversity led to the expectation that orthographies would draw somewhat unequally upon a range of cognitive abilities, and that the cognitive demands associated with different systems should be reflected in the pattern of reading errors (see Liberman et al. 1980). Mainly, the findings confirm these expectations, and also the expectation that cross-language comparisons of the progress of beginning readers have potential value for delineating more precisely the set of specific skills required for mastery of each orthography. The present study of reading errors in beginning readers of Italian, together with the comparative findings on English and Serbo-Croatian, points to significant differences in reading processes that are associated with these three orthographies that share the alphabetic principle. At the same time, the findings point to the existence of common problems in learning to read in an alphabetic system.

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NOTES

1. In English, the vowels tend to have multiple spellings, whereas consonants display greater consistency in grapheme-phoneme correspondences (Venezky 1970).
2. An exception is the voiceless velars /k/ and /g/ which have a different spelling depending on the following vowel. The letters *c* and *g*, when followed by the vowels /a/, /o/ and /u/ are rendered as voiceless stop consonants /k/ and /g/ respectively. When followed by the vowels /e/ and /i/, they are rendered as affricates /tʃ/ and /dʒ/.
3. It is possible, of course (as suggested in Fischer et al. 1978) that children who evince widespread impairment of higher visual processes may face a special obstacle in coping with the visual processing requirements of reading.
4. See Gough & Hillinger (1980) for further information on the rate of learning decoding skills in reading by English-speaking children.
5. H. Wimmer (1993), in a recent study of reading errors by beginning readers of German, also reports fewer errors on vowels than on consonants. English thus appears to be the outlier.

APPENDIX 1: WORD READING LIST FOR CONSONANTS (UPPER AND LOWER CASE)

Target	1st syllable		2nd syllable	
[B]	baci	*kisses*	ruba	*s/he steals*
	bocca	*mouth*	cibo	*food*
[C]	cena	*dinner*	brace	*ember*
	carte	*cards*	buca	*hole*
[D]	dado	*die*	corda	*rope*
	doni	*presents*	grido	*scream*
[F]	faro	*lighthouse*	buffa	*funny*
	filo	*threat*	gufi	*owls*
[G]	gara	*competition*	strega	*witch*
	gelo	*frost*	urge	*it urges*
[L]	lato	*side*	gola	*throat*
	lepre	*hare*	sale	*salt*
[M]	mela	*apple*	rame	*copper*
	mano	*hand*	crema	*cream*
[N]	nero	*black*	pane	*bread*
	naso	*nose*	vena	*vein*
[P]	palo	*pole*	rapa	*turnip*
	pollo	*chicken*	rospo	*toad*
[Q]	quadro	*picture*	acqua	*water*
	questo	*this*	cinque	*five*
[R]	riso	*rise*	ieri	*yesterday*
	rami	*branches*	sera	*evening*
[S]	seme	*seed*	scuse	*apologies*
	sole	*sun*	casa	*house*

Appendix 1 *(Continued)*

Target	1st syllable		2nd syllabe	
[T]	tino	*vat*	denti	*teeth*
	tana	*lair*	trota	*trout*
[V]	vigna	*vineyard*	rovi	*bramble*
	vaso	*pot*	riva	*shore*
[Z]	zanna	*fang*	pizza	*pizza*
	zoppo	*flame*	quarzo	*quartz*

APPENDIX 2: WORD READING LIST FOR VOWELS (UPPER AND LOWER CASE).

[A]	art	ant	sab	car	spa	cra
[E]	erp	est	set	der	pre	sme
[I]	int	inc	mit	cip	cri	spi
[O]	ont	ort	cor	fon	sto	pro
[U]	urt	umb	sup	cub	stu	tru

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