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IMMERSION CHILDREN'S USE OF ORTHOGRAPHIC STRUCTURE FOR READING

Margaret Mes-Prat

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CURRICULUM STUDIORUM

Margaret Mes-Prat was born October 18, 1952, in Bandung, Indonesia. She received the Bachelor of Arts (Linguistics, Mathematics) degree from the University of Ottawa (Ottawa, Ontario) in 1973. During 1973-74, she spent a year studying psycholinguistics at the University of Amsterdam (Amsterdam, Netherlands).

ABSTRACT

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Margaret Mes-Prat

University of Ottawa

This study was conducted to investigate the use of orthographic constraints in reading first and second languages; it also sought to examine any differences between stimuli containing spelling patterns typical of one language and stimuli containing spelling patterns common to both languages. Grade three and six immersion boys were presented with English and French words, pseudowords, and nonwords. The stimuli were given tachistoscopically for 24 msec; the proportion of correct recognitions was the dependent measure. It was reasoned that orthographic structure was being used for reading if pseudowords were significantly better recognized than nonwords. The results did not unequivocally confirm the typical versus shared spelling pattern distinction. Recognition accuracy for pseudowords and nonwords indicated that grade six boys were using the orthographic constraints in their native language (English) and in their second language (French). The grade three boys also used intraword redundancy in both their languages, although the difference between pseudowords and nonwords was greater in their language of instruction (French) than in their native language (English). Overall, the results

indicated that the immersion children were aware of the orthographic regularities of both their languages. The correlations found between the English and French words and pseudowords suggested that the immersion children used their "set for structure" when trying to read in their native language. The present research supports the view that orthographic constraints are not a problem when reading a second language.

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INTRODUCTION

Experiments on the perception of words have proliferated ever since Cattell (1886) demonstrated that one could read as many as four connected short words in the same amount of time as one could read four unconnected letters. At the time, Cattell attributed the word superiority effect to meaning; recent evidence has implicated several other factors, not the least of which is orthographic structure.

Although in the adult reading process, syntactic and semantic structure play a large role in the process of efficient reading, at one time orthographic structure had to be mastered in order to recognize words. Developmentally, it can be shown that as reading ability increases, orthographically legal pseudowords gain an advantage over orthographically illegal nonwords. Presumably, the child who is exploiting orthographic structure has internalized the constraints inherent in a language such that the time taken to recognize a patterned pseudoword is shorter than that for a nonword; if the exposure time is kept short and constant the recognition accuracy will be greater for the former than for the latter.

Turning to the question of immersion programs in the elementary schools, investigators have been anxious to evaluate the effect of such programs on the acquisition of such a basic skill as reading. English children who have followed French immersion

programs have been shown to make quick progress once a daily English Language Arts period has been introduced. After one or two years of formal English training, the immersion children perform at a level appropriate to their grade on standard reading tests. If the semantic and syntactic context is eliminated, can the immersion child exploit the orthographic constraints of each of his languages in order to increase his recognition accuracy during a brief tachistoscopic exposure? Assuming that spelling patterns are an important variable in word recognition experiments, will the immersion child do as well with the typical spelling patterns of a language as with those that are shared by the two languages? How does the performance of a grade three immersion class compare to that of a grade six immersion class?

These are the basic questions to which this research addresses itself. In the first chapter, a review of the relevant literature will be given and the hypotheses formulated. The second chapter will describe the subjects, procedure and materials used; the method of statistical analyses will conclude the chapter. The results will be given in chapter three followed by a discussion in chapter four.

CHAPTER I

Review of the Literature

In this chapter, a review of the relevant literature will be made: in the first section, the methodology and rationale of word perception experiments will be considered; this will be followed by a summary of the work done on the developmental aspects of word perception. The last section will review the literature on bilingualism and reading. The chapter will conclude with the hypotheses used in this research.

Word Perception

Researchers have considered the problem of word perception as an important first step in understanding the total reading process. Although an efficient reader has the impression that he perceives words on a "wholistic" level, recent experiments have demonstrated that there are several important variables in the way words are perceived. In an attempt to isolate the various factors involved, experimenters have created laboratory situations which often seem only remotely related to the reading process. Methodological issues are not a trivial matter since the results can be interpreted differently depending on the instructions given to the subject; therefore, these issues are considered briefly here.

Smith and Spoehr (1974) identify two types of tasks which are commonly used: the stimulus is presented for a brief exposure time,

in which case the dependent variable is the accuracy of the response, or the stimulus is presented for a long exposure time, in which case reaction time (latency) is measured. Different measures are possible: some investigators have held the contrast level constant and have varied the exposure time until correct recognition has occured (Postman and Adis-Castro, 1957) or, inversely, they have held the exposure time constant and varied the contrast level (Lott and Smith, 1970).

Although Smith and Spoehr (1974) conclude that there is convergence between the results of reaction time and accuracy experiments, it nevertheless remains to be seen whether the different task requirements are tapping the same processes and what their relation is to reading. Within the accuracy measure, investigators have had subjects: a) report what they saw by spelling it out loud or by writing (total report method), b) choose between several alternatives of the whole stimulus (forced-choice technique), c) choose between two alternative letters in a probed-for letter position (recognition procedure), d) decide whether two stimuli are the same or different (comparative judgment). Within the reaction time measure, subjects have been asked to: a) decide whether a stimulus is a word or not, b) decide whether two stimuli are the same or different, c) search for a target letter in a letter string. Several criticisms have been made against the different procedures. Smith and Spoehr criticize the total report method because they feel

it primarily reflects variations in the non-perceptual stage; they imply that only forced-choice procedures are relatively free of memory and guessing factors. However, since these two factors have been implicated in the reading process, the choice depends on the goals of the experimenter. Reaction time procedures have the disadvantage of confounding motor response and decision times; of course, inasmuch as this is a constant aspect of all the different types of stimuli, it is not a hindrance. However, the different reaction time tasks require different types of decisions and are thus not entirely comparable. These considerations must be kept in mind when evaluating the different experiments.

Several investigators have given excellent reviews of the word perception problem (Bradshaw, 1975; Gibson & Levin, 1975; Smith & Spoehr, 1974). Thus only some topics relevant to this particular research will be discussed. The fundamental question in the field of word perception is: Why are words more accurately perceived than unrelated letter strings of the same length? Or, put differently, why does it take less time to perceive the former as compared to the latter? The two questions are equivalent since, as Smith and Spoehr (1974) have argued, variations in accuracy reflect variations in the probability that the subject had sufficient time to fully process the stimulus; thus a decrease in accuracy points to an increase in the time needed for processing.

It is useful to point out that words can be described on several levels: graphic, phonological, orthographic, semantic,

syntactic (Gibson, 1972); these levels constitute objective variables. Subjective variables such as frequency, familiarity and expectation have also been used to describe words; all of these variables have been shown to exert a significant effect on perception and recall. Among the objective variables, the important finding is that, even when meaning and familiarity are absent, phonological and orthographic regularity are important factors in word perception. This implies that it is not only whole words which are learned but some higher-order unit which is larger than a letter but smaller than a word (Neisser, 1967; Gibson & Levin, 1975). This seems like a very reasonable finding since most people have been taught to read by analyzing words in order to sound them out.

This was the rationale underlying the Gibson, Pick, Osser, and Hammond (1962) study; they felt that letter clusters which had invariant sound-spelling relations were the important unit to study. Accordingly, they constructed lists of pronounceable and unpronounceable words using letter clusters in the constrained position for the former and in the illegal position for the latter (e.g., 'glurck' versus 'ckurgl'); ratings by 165 subjects confirmed the pronounceable versus unpronounceable distinction. In the first experiment, the stimuli were presented tachistoscopically to the same subjects for increasing exposure times (30, 50, 100, 150 and 250 msec). The subject was instructed to write down what he saw and guess when he could. The most obvious result

of the experiment was that the pronounceable items were consistently superior to the unpronounceable ones and that the two curves were parallel; there was 75% accuracy for the pronounceable items at 250 msec. Additional findings were that errors tended to increase with the length of the word and transformations of the actual stimulus changed the letter group into a more regular sequence (e.g., 'nikid' for 'nkid').

To exclude the possibility that these results were simply due to a response bias factor, Gibson et al. performed a second experiment using a forced-choice technique and a fixed exposure time (30 msec). Eighty percent of the previous stimuli were used and the alternatives for the multiple choice were taken from the most frequent errors of the previous experiment. The results from this experiment confirmed those of the previous one. The researchers concluded that "the perceptual process has been facilitated in skilled readers for units discovered during long exposures to the grapheme-phoneme correspondences of the English language" (p. 570). These findings give empirical validity to Fries' (1962) linguistic analysis of the reading process: "Learning to read ... means developing a considerable range of habitual responses to a specific set of patterns of graphic shapes" (p. 121).

Many experiments since then have confirmed the importance of orthographic structure. Gibson, Bishop, Schiff, and Smith (1964) demonstrated that when pronounceability and meaningfulness are

uncorrelated (as in well known abbreviations such as IBM), the perceptual threshold is lowest for the pronounceable trigrams; these results were obtained by varying the contrast and holding the exposure time constant (40 msec). Furthermore, Gibson, Shurcliff, and Yonas (1970), using the same stimulus material and method as in the Gibson et al. (1962) experiment, replicated their previous finding with deaf subjects. Contrasting the hearing and deaf subjects, they noted that the latter made more errors than the hearing subjects but that the difference between pronounceable and unpronounceable items was still significant. These results seriously weakened the argument that cross-modal experience in reading was a necessary condition for the acquisition of the spelling patterns.

Using the letter recognition technique, Aderman and Smith (1971) provided additional support for Gibson et al.'s (1962) hypothesis that spelling patterns are the functional units. They developed their stimulus material in the same manner as Gibson et al.; however, they also manipulated the expectancy of the subjects. Those subjects who expected unrelated letter strings and were presented spelling patterns did relatively poorer than those who expected and got spelling patterns. Aderman and Smith saw this as proof that in previous experiments, subjects were adopting the efficient strategy of expecting spelling patterns, even though the lists were mixed.

In a series of very interesting experiments, Baron and Thurston (1973) sought to analyse the word-superiority effect. In their first experiment, they presented words, pronounceable nonwords, and unpronounceable nonwords (e.g., 'cars', 'cors', 'csra'); after a brief tachistoscopic presentation (24 or 32 msec), they probed for letter recognition on those letters which were the same on all three types of stimuli. Since words and pronounceable nonwords did not differ in their accuracy scores, Baron and Thurston concluded that the word-superiority effect may be accounted for entirely by pronounceability. However, since they never probed the medial vowel of the words and pronounceable nonwords, the evidence is not conclusive in dismissing frequency and meaningfulness as important variables.

Experiments two to four confirmed the previous results and also indicated that a mutual facilitative effect between letters was not the mechanism responsible for the word-superiority effect. Experiment five showed that the effect of pronounceability held up even when the visual memory span was not taxed (only two letters were used). Using homophones in experiment six, Baron and Thurston were able to demonstrate that the sound of the word was not an important variable. In an attempt to separate spelling regularity from pronounceability, they tested chemists and non-chemists for correct and incorrect chemical formulas (anions and cations were reversed). Looking at the amount of time it took to decide

whether pairs of formulas were the same or different, they found a significant difference between the two types of formulas for the chemists only. This last experiment demonstrated that spelling rules which are not related to pronounceability are learned and can be used in a matching task.

This set of experiments provides impressive evidence for the role of orthographic structure; subsequent experiments have all confirmed this effect (Barron & Pittenger, 1974; Chambers & Forster, 1975; Greenberg, 1974; Richardson, 1976; Spoehr & Smith, 1975). The problem remains of defining which characteristics of orthographic structure permit this pronounceable-unpronounceable pseudoword difference. As Smith and Spoehr (1974) point out, nearly all theoretical models of word perception assume some higher-order perceptual unit. In this respect, Gibson et al. (1962) had already suggested the "spelling pattern unit"; the problem with the latter model is that it assumes "that humans are capable of parsing letter-strings into spelling-pattern units before the letters have been categorized" (Smith & Spoehr, 1974, p. 257). In an effort to circumvent this problem, Spoehr and Smith (1975) proposed that letters are first identified and then an orthographically dependent unitization stage parses the string into vocalic center groups, which in turn are translated into a code (acoustic or articulatory). Since orthographic structure reduces the number of units to be translated, the probability is increased that all processing will be complete under conditions

of brief presentation. In an experiment which was designed as a critical test of the spelling pattern versus vocalic center group proposals, Spoehr and Smith found that accuracy scores ordered in the following manner (from highest to lowest): words (e.g., 'blast'), pronounceable pseudowords (e.g., 'blost'), spelling pattern letter string (e.g., 'blst'), unrelated letter string (e.g., 'lstb'). The results confirmed their prediction that a letter string which contains a vowel is more perceptible than one that does not, even though the consonant string contains one less letter. However, the spelling pattern items differed significantly from the unrelated items and this finding provides strong support for the "psychological reality" of spelling patterns. Extending the vocalic center group model to incorporate these new findings, Spoehr and Smith used a recoding scheme which could account for 35% of the variability in their results. This syllabic recoding scheme was also very accurate in predicting where native English speakers would insert vowels in order to make unrelated strings into pronounceable nonwords (e.g., insert 'o' and 'i' into 'RSNT' to make 'ROSINT').

Spelling patterns and vocalic center groups are not the only characteristics which permit a pseudoword-nonword difference to be found. Miller, Bruner, and Postman (1954) had already demonstrated that transitional probabilities had a significant effect on accuracy. They presented four different orders of approximation to

English: zero order is constructed by choosing each letter independently of the other whereas fourth order is constructed by taking a triad of letters and searching for a fourth letter which commonly follows. Accuracy increased proportional to the order of approximation; of course, orthographic regularity increased concomitantly. These results emphasize the fact that orthographic structure is not an all-or-none phenomenon; they also lead to different interpretations of the word superiority effect, i.e., sequential redundancy is the effective variable. However, many researchers have argued against such an interpretation (Gibson & Levin, 1975; Mewhort, 1966; Smith & Haviland, 1972; Smith & Spoehr, 1974); in every case, the researchers have attempted to show that the subject does not merely guess on a letter-by-letter basis but rather, he is using the higher-order units that are available. Whatever may be the crucial factor or factors which contribute to the effectiveness of orthographic structure, the next section will try to demonstrate that its use will increase with reading efficiency.

Developmental Aspects of Word Perception

Already in 1927, Hoffman (quoted in Gibson & Levin, 1975) had shown that, between grades one and eight, there was a clear developmental trend which distinguished four classes of stimuli: unconnected consonants, nonsense syllables, unfamiliar words, and familiar words. During the same brief exposure time, grade eight pupils were able to read twenty letters that formed familiar words

whereas grade one pupils could only read five letters; unfamiliar words also showed a marked increase in span. Such a dramatic increase was however not noted for either the nonsense syllables or the unconnected consonants.

Over the last two decades, it has been shown that, as reading experience increases, not only words but also pronounceable pseudowords gain an advantage relative to unrelated letter strings. Although various researchers have attributed the effect to different variables, they all agree that the successful young reader has internalized some particular knowledge about the language he is reading; this is not mere association of a response to a stimulus but some abstract process (Gibson, 1972).

In one of the first articles on the subject, Gibson, Osser, and Pick (1963) wished to demonstrate that children did not merely learn whole words by rote; pronounceable pseudowords would also facilitate recognition, if grapheme-phoneme correspondences had been established. In order to test this hypothesis, they used three-letter words, pronounceable trigrams and unpronounceable trigrams (e.g., 'put', 'tup', 'ptu') which were presented for 10 msec to grade one and three pupils; the subjects reported what they saw by attempting to pronounce the stimulus and later by spelling it. The results indicated that even the grade one pupils read the pronounceable trigrams better than the unpronounceable ones; the grade three girls read the three types of stimuli with equal

accuracy, suggesting that three-letter strings were not sufficiently long for the effect to operate. In a second part of this same experiment, the four- and five-letter stimuli from the Gibson et al. (1962) study were used; the more complex rules used to generate these pseudowords proved to be more discriminating. For the grade one pupils, both the unpronounceable and pronounceable pseudowords were read with a 5% accuracy; the third graders showed an increased span and the difference between the two types of stimuli was highly significant. The experimenters concluded that by grade three, the young reader was already perceiving some of the regularities of correspondence between sound and spelling. Although in this experiment, having the children pronounce the stimuli may have differentially lowered the recognition accuracy of the unpronounceable pseudowords, recent experiments have confirmed these results.

Hypothesizing that the previous results with trigrams were largely due to the children's familiarity with the CVC pattern, Thomas (1968) tested grade one, two and three pupils with four classes of stimuli: words, CVC trigrams and pronounceable and unpronounceable CCV trigrams; all stimuli were presented for 40 msec and responses were verbal. For all types of stimuli, the recognition accuracy was 75% or better; at all grade levels, only the two CCV trigrams were not significantly different from each other. Thomas concluded that it is not pronounceability per se

which may be important, but rather, familiarity with a certain type of visual unit.

Rosinski and Wheeler (1972) replicated the Gibson et al. (1963) results using a different task. They presented pairs of pseudowords (one pronounceable, one unpronounceable) to first, third and fifth grade children; they asked each child to identify which stimulus of the pair "was more like a real word" (p. 97). The first grade children performed at a chance level, whereas the third and fifth grade children's performance ranged between 69% and 80%; the older children thus seem able to discriminate between words and nonwords on the basis of spelling patterns occuring in the constrained position. At the beginning of the grade two school year, nine of the original sixteen grade one students still did not show any signs of distinguishing the two types of pseudowords.

Using pairs of words as in the previous experiment, Golinkoff (1974) tested first and second graders' ability to distinguish "wordlikeness"; furthermore, she tested their ability under three conditions: visual alone, auditory alone and combined. As might be expected from the previous experiment, in the visual alone condition the grade one pupils performed only 3% above chance whereas the second graders had 82.5% correct. Another finding of interest was that the first graders' did best under the combined condition whereas the second graders' performance was maximum in the visual alone condition. This suggests that spelling to sound relations

may be important in grade one but that orthographic (visual) features are more important in grade two. The task tapped an ability related to reading proficiency since the correlation with a standardized reading test was significant ($r = .50$).

Lefton, Spragins, and Byrnes (1973) took a somewhat different approach to the developmental issue. They reasoned that as reading experience increased, so would the ability to guess a missing letter in a constrained pseudoword. Using first, third and fifth grade children, they presented them with seven-item pseudowords which were either first-order or fourth-order approximations of English; an additional variable was whether the missing letter was in the right or left half of the word. As might be expected from the previous results, the grade one's guessing accuracy was equally low (4%) for the two types of pseudowords. By grade three, guessing accuracy had significantly improved for the right side of the fourth-order pseudowords only (16%); correct guesses for first-order pseudowords had remained low. Grade five pupils achieved the same accuracy level as the adults used in the Lefton (1973) experiment (the same stimuli were used); the gap between first- and fourth-order pseudowords had widened further. The experimenters concluded that fifth grade children can use the sequential constraints of English as adults do.

Using eight-letter strings, Lefton and Spragins (1974) also came to the same conclusion. They used the same grade levels and

types of stimuli as in the previous experiment; the exposure times were 50, 100, 150, 200 and 300 msec. Again, grade three and five, but not grade one, children showed differences between the two types of stimuli; the oldest children had adult-like performance levels. They concluded that the subjects were chunking the units for more rapid processing and that adult processing levels were reached by about fifth grade. This would agree with the finding from the Lott and Smith (1970) experiment: they found that adults and fourth graders did not differ significantly from each other on the reading of simple trigrams. However, Gibson and Guinet's (1971) experiment still shows a sizeable difference between grade five students and adults on the pronounceable and unpronounceable pseudowords. Since Gibson and Guinet used stimuli which varied between three and nine letters, it may have been that their task was more discriminating.

Thus far, the developmental trends found have implied that as reading ability increases so does the capacity for exploiting the constraints inherent in a language. But what exactly is the magnitude of the relation? Golinkoff's (1974) results have already been mentioned: the relation thus seems already to be evident in grade one and two. A study by Wallach (1963) extends these results to grade five children. Wallach obtained ratio scores (gain of perceptual accuracy for fourth-order as compared to zero-order words) which he correlated with the reading score on the Metropolitan

Achievement Battery; he found a significant correlation of .37. However, his fourth-order words rarely used any of the complex consonant clusters so typical of English; also, he adjusted the exposure time for each subject such that 33% of the zero-order letters were correct. These factors may have tended to lower the magnitude of the relation found. Thus, it is still not clear from the above results whether efficient readers are quicker or more knowledgeable at using the redundancy of the language.

In this respect, Mason's (1975) experiments give a tentative answer. She examined the possibility that good and poor grade six readers differed in their use of spatial frequency redundancy. The latter was defined as "how often any one letter occurs in a particular position in a given string length" (p. 148); it is distinct from sequential redundancy which reflects "the constraints that characterize valid spelling patterns and letter sequences in words" (p. 148). Spatial frequency redundancy is not unrelated to the concept of orthographic structure since if the latter is present there will necessarily be high spatial frequency redundancy.

Mason asked her subjects to find a target letter in a six-letter display; she used as dependent measures the time taken to look at the target letter and the reaction time for the search. Both catch and target trials were run. In her first experiment, Mason used words and random letter strings. In agreement with the Katz and Wicklund (1971, 1972) results, Mason found no difference

between good and poor readers on the amount of time they spent looking at the target letters. On both catch and target trials, there was a significant difference between the word and nonword reaction times for the good readers only. An analysis of the percentage of errors according to type showed the same trend.

The second experiment used words and nonwords, the latter being either high or low in spatial frequency redundancy. The nonwords were anagrams of the words (e.g., 'seldom', 'somled', 'sdelmo'). Although Mason does not mention it, her three categories probably are quite similar to those of word, orthographically legal pseudoword and orthographically illegal pseudoword. The results of this experiment again showed a significant interaction between reader ability and type of display, but only for the catch trials. The good and poor readers had the same latencies for the low spatial redundancy words; the good readers however had much lower reaction times for both the real words and the highly redundant nonwords. The poor readers did not show any appreciable difference between the three types of displays. Since Mason's subject selection procedure tried not to confound the variables of reader ability and general achievement, the results can validly be interpreted as differences specific to reading ability.

Mason's experiments demonstrate that even in grade six, reading efficiency can be related to the use of redundancy. Good readers are quicker at identifying a letter when it is in a redundant

context; they seem able to augment distinctive feature information with redundancy information.

There remains the question of whether accuracy in word recognition is necessarily mediated by some phonemic recoding. Gibson, Pick, and Osser (1963) favoured such an interpretation with their experiment on grapheme-phoneme correspondences. They have since changed their point of view, since Gibson et al.'s (1970) experiment with deaf adults has indicated that auditory information is not a necessary condition for the use of orthographic structure. Doehring and Rosenstein's (1960) experiment with 10 and 13 year old deaf and hearing children extends this finding to younger subjects. They presented four types of stimuli for 10 msec: single letters, pronounceable trigrams, unpronounceable trigrams and words. At both age levels, there was a significant difference between the reading vocabularies of deaf and hearing subjects; as might be expected, the 10 year old hearing subjects consistently performed better than the deaf subjects but this was not true of the older subjects. Looking at the differences between the number of errors on the pronounceable versus the unpronounceable trigrams, the experimenters concluded "that, if anything, the deaf children were aided more by pronounceability in the list of trigrams than were the hearing children " (p. 324); however, it should be remembered that the patterns used were of the simple CVC type. In this respect, it may be recalled that Thomas (1968) had suggested that familiarity

with certain visual units was more important than pronounceability and that Golinkoff's (1974) results also emphasized the importance of the visual mode. Thus, even grade three children may be bypassing phonemic recoding in word recognition.

From the experimental literature, a summary of the developmental trends can be made. The child must begin with the identification of letters, he must learn the distinctive features of the different letters in order not to confuse them (Gibson, Osser, Schiff, & Smith, 1963). Already in kindergarten, non-readers use letter cues rather than a shape cue in order to recognize words (Marchbanks & Levin, 1965). In grade one, children have a certain sight vocabulary which they sometimes use to guess at other words which they do not yet recognize. Their errors are characterized by the fact that the replaced word is determined by the semantic and syntactic context; it bears little relation to the graphic display (Weber, 1970). However, they already seem to perceive the regularity of the familiar CVC trigrams and are able to generalize this to pronounceable pseudowords (Gibson, Osser, & Pick, 1963; Thomas, 1968). But their knowledge of the written language is still very limited.

By the end of grade one, most children have gone through a "no-response" stage (Biemiller, 1970). During this stage, the child stays silent when he encounters a word that he does not know; he is attempting to "break the code" (Gibson, 1972). It is obvious

that here, a knowledge of sound-spelling relations come into play. Gradually. the child integrates the graphic constraints of the printed word with the semantic context clues.

By the end of grade two, most children can use the more complex spelling patterns to identify "wordlikeness" (Golinkoff, 1974; Rosinski & Wheeler, 1972). There is sufficient familiarity with the written language for pronounceable pseudowords (or fourth-order approximations) to have a distinct advantage over unrelated strings in a time-limited task (Gibson, Osser, & Pick, 1963; Lefton & Spragins, 1974). By grade five most children are operating at a level close to that of adults (Lefton & Spragins, 1974; Lefton, Spragins, & Byrnes, 1973). By this time "the orthographic features demand a lesser share of the child's attention" (Gibson, 1972, p. 358) and he is free to pay more attention to the meaning of the text. However, even in grade six, good and poor readers can be differentiated on their ability to use the redundancy of a word display (Mason, 1975). Thus, nonefficient readers still seem to be caught up in the mechanical aspects of the reading process.

How is this ability to use orthographic structure acquired? Eleanor Gibson (1970) places this issue in the larger context of her theory of perceptual learning. She believes that invariant distinctive features are abstracted and then generalized. Certainly this is true in many areas of language: the two year old somehow

discovers the critical features of a phoneme in spite of large variations in the samples of speech he hears; the five year old knows certain grammar rules well enough to generalize to nonsense words. Gibson is convinced that spelling patterns are what are learnt by the child; she reports an interesting experiment in which first and third grade children are asked to search for colour and letter patterns. It was concluded from this experiment "that a set for structure can be developed and can transfer to new problems, and that the ability to detect structure in letter patterns improves with age and schooling" (Gibson, 1970, p. 142). Of course, spelling patterns necessarily imply high sequential and spatial redundancy and thus Gibson's viewpoint is not incompatible with that of other workers. Although it is not sure whether the spelling patterns function as units that are immediately apprehended without analysis, they would certainly facilitate the search through the lexicon and thus promote more efficient reading habits.

Bilingualism and Reading

The problem of bilingual education has become the focus of much attention in recent years. In the United States, the impetus has come from the finding that cultural minority children (e.g., Chicanos) were doing very poorly in the regular programs (Garcia, 1973); in Canada, the success of Montreal's St. Lambert project (Lambert & Tucker, 1972) created a wave of enthusiasm for

immersion programs. In Canada, it is the culturally dominant group which has learned the language of the linguistic minority, whereas in the United States, a culturally disadvantaged minority has had to learn the language of the majority. Therefore, the results of the bilingual programs in each country are not always comparable.

Immersion in Canada usually means that a native English speaker receives nearly all his curriculum in French. Programs have tended to be of the early immersion type, i.e., begun in kindergarten or first grade, although late immersion has also been tried (Genesee, Polick, & Stanley, 1977). Different immersion projects have begun English Language Arts at different grades and have switched over to half-day English, half-day French at different levels.

With the implementation of these programs, there has been concern expressed about the possible detrimental effects of bilingual education on the acquisition of basic English skills. This fear arose largely from reports that bilinguals mastered neither language and thus remained disadvantaged compared to unilingual groups (Jensen, 1962). Results from the immersion programs in the Eastern Canadian cities (Montreal, Ottawa, Toronto) have shown that the English child suffers no lasting retardation in the acquisition of skills in English and has made significant gains in his mastery of French, although he rarely is on par with a native French speaker (Edwards, 1976; Lambert & Tucker, 1972;

McInnis, 1976; Swain, 1974, 1976). Any lag in the child's English skills is temporary and is quickly overcome once a daily English Language Arts period is introduced.

Although many researchers (Andersson & Boyer, 1970; Gray, 1969; Gudschinsky, 1971) have felt that "reading in the second language should be delayed until the child has become fully literate in the first language" (Modiano, 1972, p. 1), the Canadian experience with immersion programs has not shown this to be a problem. Tucker (1975) reports that in the St. Lambert immersion program, "no attempt is made to teach the children to read in English, and parents are specifically urged not to do so in the home" (p. 52); only French reading is taught in the first grade. Predictably, in this grade the immersion children lag behind the regular program children in reading English but by the end of grade two, when two half-hour English Language Arts periods have been introduced, these same immersion children do not differ significantly from the regular program children on a standard reading test; this trend is again verified in testing the same group when in grade seven. In French, the immersion children are never quite as good as the French control group, although the difference is not statistically significant in the lower grades; in grade seven they are still experiencing difficulties in reading complex French excerpts. Furthermore, Tucker points out that in grades one, two and seven there is a significant correlation of .42, .60, and .42, respectively, between

the results on the English and French reading tests; this he sees as "evidence for a positive transfer of skills across languages" (p. 55).

Barik and Swain (1975) have obtained similar results for the three successive Ottawa immersion groups they have studied. In French, the immersion children compare favourably with the French control group, but they only score between the 30th and 60th percentile on a standard English reading test. Although Barik and Swain do not rule out the possibility that exposure at home may account for some of the results, they repeatedly attribute their results to "substantial transfer of reading skills from French to English" (p. 13). Therefore it is not surprising that the grade two immersion pupils "catch up" to their regular program peers once the English Language Arts period is introduced. This finding has been replicated in the Ottawa and Carleton Separate School Board immersion programs (Edwards, 1976; McInnis, 1976), as well as in the Allenby (Toronto) School Project (Barik, Swain, & McTavish, 1974). In the only American immersion program which models itself on the Canadian programs (Culver City), the same results were also obtained (Cohen, 1974, 1975).

Swain (1974) has suggested that it is easier to transfer to one's native language since "sound patterns, vocabulary and language structures are already well-established" (p. 121). Although French may be somewhat more regular in its spelling-to-sound correspondences

than English (Swain, 1974), both are classed as being among the most imperfect and arbitrary of all modern languages (Levin & Watson, 1963). The fact that French orthography is just about as irregular as English orthography may be of considerable help, since it has been shown that adults who have been accustomed to regular sound-to-spelling correspondences (e.g., Spanish, Italian) have found it relatively difficult to decode variable grapheme-to-phoneme correspondences (Levin, Baum, & Bostwick, 1963). This may in part explain why Cohen, Fathman, and Merino (1976) found that when Spanish and English reading were introduced simultaneously, their bilingually-trained children did not do as well as monolinguals.

Cowan and Sarmed (1976) predict transfer of elementary reading skills for languages such as French and English which have "near identical orthographies, greater structural similarities, and a high number of cognates" (p. 100). Since Persian and English are very dissimilar languages, it is not surprising that their Persian-English bilingual children were behind their monolingual peers on the reading tasks they gave them. Although Cowan and Sarmed note that several variables may have influenced their results, they nevertheless postulate that for two very different languages, the child must develop two separate attack skills.

McNamara (1966) is another researcher who has not endorsed the view that bilinguals read as well in their dominant language as monolinguals. In an attempt to analyse the difficulties which

English-Irish bilinguals may encounter, McNamara (1970) had grade six boys read aloud three times an English and Irish version of a math problem. Looking at the amount of time it took to read each passage, he noted that improvement from first to best time was greater when reading the Irish version, the boys' weaker language; he concluded that the initial reading speed in Irish gave an indication of the speed at which the boys could comfortably handle semantic information.

In an analysis of reading in French and English, McNamara, Feltin, Hew, and Klein (1968) performed a series of experiments with English-speaking college women who had had several years of French as a second language. They measured the perceptual threshold of French and English words and sentences; they also measured the time taken to determine whether a picture and a word, or a picture and a sentence, matched. The results showed that perceptual thresholds for words and sentences were comparable in both languages; however, there was a significant difference between English and French in the speed with which subjects determined the meanings of words and sentences. These results agree well with those of Lambert, Havelka, and Gardner (1959) who had noted that the speed with which a subject recognizes a word was related to his proficiency in the language.

Since syntax failed to show a significant effect in the above experiment, the researchers extended the picture-sentence matching

task to include more complex syntactic structures. Using English-speaking and French-speaking subjects who had acquired school knowledge of the second language, the results clearly indicated that the subjects performed the task more rapidly when the stimulus was in their native language. Since the subjects knew each word and understood each syntactic structure of their weaker language, there seems to be a difference at the speed at which they can interpret words and use the redundancy of the language.

Cziko (1977) also concluded that the second language learner's reading difficulties lie mainly in his inability to recognize and make use of syntactic and semantic constraints. Using three groups of seventh grade English-speaking students with varying degrees of proficiency in French, Cziko presented them with unconstrained (random), syntactically constrained (anomalous), and semantically constrained (meaningful) paragraphs in both languages. As expected, the students were able to use the constraints in English; however, only the group most proficient in French was able to take advantage of the syntactic constraints present in the anomalous paragraph and none of the groups were able to take advantage of the semantic constraints present in the meaningful paragraph. This relation between language proficiency and type of constraint which can be used for reading was also found in adults by Théberge (1976): the group most proficient in the second language was able to apply first language reading strategies to second language reading. Analyzing the errors made in reading, Williamson and Young (1976)

also concluded that young bilingual students are not as sensitive as monolinguals to the grammatical and semantic cues of their weaker language. Many other researchers have emphasized the importance of syntactic and semantic knowledge for reading in the second language (Bialystok & Fröchlich, 1977; Cowan, 1976; Goodman, 1971).

The previous studies suggest that word perception is not a problem in second language reading : any difficulties which are encountered lie in the syntactic and semantic realm. None of the studies have explicitly looked at the use of orthographic constraints for reading in the first and second language. Gibson (1970) maintains that "a set for structure can be developed and can transfer to new problems" (p. 142). Lambert and Tucker (1972) believe that the immersion child develops a "linguistic 'detective' capacity, that is, an attentive, patient, inductive concern with words, meanings and linguistic regularities" (p. 208). The child who begins reading in one language will already have some experience with abstracting grapheme-to-phoneme correspondences. This experience will be useful when he attempts to read in another language; furthermore, if both languages have irregular sound-to-spelling correspondences and share a number of spelling patterns, a great deal of positive transfer can be expected. Therefore, it should take considerably less than two years of formal training to acquire the use of spelling regularities (Golinkoff, 1974). On the other hand,

if there is little transfer between the two languages, the immersion child who is beginning to read in English should be at the level of the grade one students tested by Gibson, Pick, and Osser (1963).

Summary and Hypotheses

This review has attempted to demonstrate that orthographic structure is an important variable in word recognition and that its use is fundamental to efficient reading. In this particular research, spelling patterns are the units which will be used to construct the stimulus material; furthermore, it is reasoned that if spelling patterns are abstracted and retained as units and if recognition of these patterns is influenced by frequency of exposure, then pseudowords which contain patterns common to both English and French should evidence some superiority to words which contain only patterns typical of one language. Thus if grade three and six immersion students are presented with stimuli varying in familiarity and structure, some specific outcomes may be foreseen for these bilingual students. The hypotheses being tested are therefore:

1. The grade six will consistently be superior to the grade three in French and English words, pseudowords and nonwords.

2. For the grade six, words and pseudowords will be recognized equally well in both English and French.

3. For the grade three, French words and pseudowords will be recognized better than English words and pseudowords.

4. For the grade six, orthographic structure will be exploited in both languages, i.e., pseudowords will be better recognized than nonwords.

5. For the grade three, orthographic structure will be exploited in French only.

6. For grade six, words will have a distinct advantage over pseudowords, in both languages.

7. For grade three, words will have a distinct advantage over pseudowords in both languages.

8. For both grades, pseudowords containing spelling patterns common to both languages should have an advantage over those which contain spelling patterns typical of one language only.

CHAPTER II

Method

This chapter will render explicit the method used for this experiment. The first section will describe the sample, the second section, the stimuli and instruments of the study. The third section will give the details of the procedure used during experimentation. The fourth section will deal with the statistical analyses used.

Subjects

Only boys were used for this experiment since significant sex differences have been noted (Gibson, Pick, & Osser, 1963). The subjects were 38 boys attending the immersion program offered by the Ottawa Roman Catholic Separate School Board. Half of the subjects were in grade three and half were in grade six. At each grade level, 11 subjects were selected from McMaster Elementary School while the remaining 8 subjects were drawn from St. Christopher Elementary School.

At the grade six level, the total number of boys enrolled in the two classes selected served as subjects. Since at the grade three level, the total number of boys was more than required for this study, a random sample was taken. Consent was obtained from the parents for the children's participation in the study.

The mean age of the grade six subjects was 11; all but one of the children had attended the immersion program since its inception.

Seven of the grade six boys claimed that English was not the only language spoken at home; in all but one case this meant that French was also spoken at home. The mean age of the grade three subjects was 8; only three children had not attended the immersion program since grade one. Nearly half of the grade three boys reported that French was also spoken at home.

In grades one and two, the Ottawa immersion program is such that, except for religion courses which are given in English, the children receive an all-French curriculum. In grade three, a daily 75-minute English Language Arts program is introduced. In grade four, the immersion program becomes a half-day English, half-day French. Thus the grade six children that were tested already had a great deal of experience in English whereas the grade three children had had only minimal formal contact with English reading and writing.

Stimulus Material

A typical spelling pattern of one language was defined as one which was found in frequently used words of that language and which occured rarely or never in the other language. Several methods were used to fulfill these criteria. For the initial cluster patterns used in English, reference to a French dictionary verified that it was not a frequent cluster in French. Thus 'kn', 'sw', 'sn', 'spr' and 'thr' are rarely found in French and only in such recently imported words such as 'knock-out' or 'thrombose'; 'wr' is never

found as an initial cluster in French. Reference was made to the work of Blanche-Bienveniste and Chervel (1969) for some typical French patterns. In the case of the final spelling patterns, a great deal was left to the judgment of the experimenter.

To ascertain that the final position typical spelling patterns of each language were identified as such by native speakers, all French and English final patterns were rated by ten English speakers and ten French speakers. Examples of the rating scales are given in Appendix A; the verbal ratings were assigned the following numerical values: common, 3; rare, 2; nonexistent, 1. For the French native speakers, the mean rating was 2.81 for the French patterns versus 1.22 for the English patterns. A t-test for correlated samples yielded a value of $\underline{t}(9) = 35.5$, $p < .001$. Only the cluster 'nq' seemed to pose a problem: it was consistently classified as never occuring in French although it occurs in the common French word 'cinq'. For the English native speakers, the mean rating for the English patterns was 2.67 versus 1.32 for the French patterns. The difference between the means is significant, $\underline{t}(9) = 9.57$, $p < .001$. These results provided empirical validity to the classification of typical spelling patterns.

A shared spelling pattern was defined as one that occured frequently in both languages. Since real words with identical spellings in both languages were chosen, these shared spelling patterns were easily identifiable.

Four sets of stimuli were used: two French and two English. Within each language, there is a typical spelling set and a shared spelling set. Within each set, there are 10 words (orthographically legal and meaningful), 10 pseudowords (orthographically legal but no semantic referent), and 10 nonwords (orthographically illegal and not meaningful). The actual stimuli that were used are given in Appendix B. It can be seen that each list contains 3 four-letter words, 4 five-letter words and 3 six-letter words.

Within each set, a relationship exists between the word, pseudoword and nonword. In each case, the word is used to derive the pseudoword, which in turn is used to derive the nonword. Thus in the typical English spelling set, the medial vowel in the word is replaced to give the pseudoword; then the nonword is made by switching the initial consonant or consonant cluster with the final consonant or consonant cluster (e.g., 'know', 'kniw', 'wikn'). The pseudoword and nonword relationship is essentially the same as that used by Gibson et al. (1962); the method leaves the consonant clusters intact while placing them in an unconstrained position.

The relationship that exists between the three lists of each set controls for consonant and consonant cluster frequency within any one given set. In order to control for vowel frequency, the same vowels are used in the three lists.

In the typical French spelling set, the initial consonant in the word is replaced in order to get the pseudoword; the nonword

is derived by taking the initial consonant and placing it at the end (e.g., 'nuit', 'muit', 'uitm'). This is a simpler transformation than that used for the English typical spelling set; this was an inevitable consequence of the restriction that the typical polygram be kept intact.

The French and English shared sets were derived from a common word list (see Appendix B). The latter was entirely composed of words which were legitimate in both English and French; only one word ('pour') did not have the same meaning in both languages. From each bilingual word, a common stem was kept to derive the pseudoword. For the four- and five-letter words, this common stem meant keeping the first two letters, and for the six letter words, the first three letters. For the French shared set, the pseudoword was derived by adding a typical French spelling ending; for the English shared set, the pseudoword was derived by adding a typical English spelling ending. The pseudoword to nonword transformation was identical for both sets: one, two and three initial letters were placed in the final position for the four-, five-, and six-letter words, respectively.

Apparatus

The stimulus words were prepared on 5" x 8" index cards using a 60pt Helvetica Medium Letraset; this lowercase lettering was chosen because it was simple and characteristic of the typeset used in children's books. The words were photographed such that the

longest word occupied three-quarters of the width of a 35mm slide; all words were centered on the slide and were black on a clear background. When projected onto a screen which was at 6' from the viewer, the height of the letters varied between 2" and 1"; the vertical visual angle was thus $1^{\circ}30'$.

To present the stimuli, a Kodak Carousel projector was fitted with a Wollensak leaf blade shutter; the projector and shutter control was manual. A 16" x 28" white cardboard screen mounted in a wooden frame was used; the latter helped to block out distracting stimuli.

Procedure

All testing took place during the first semester of the 1976 school year (at St. Christopher during November, at McMaster during December). A pilot project was run at the end of October in order to see whether the proposed exposure time of 100 msec was adequate; it also sought to verify whether any obvious problems existed within the stimulus word sets. The pilot study revealed that a 100 msec exposure time was much too long since one of the grade three students could correctly identify all the stimulus material. The exposure time was then arbitrarily set at 24 msec. This was slightly shorter than the 40 msec exposure time used by Thomas (1968). The pilot project did not reveal any major problem with the stimulus material, although there was a slight tendency for some grade three students to substitute certain letters which

are highly confusable (e.g., 'm' and 'n'). Such substitutions are to be expected even at that age (Gibson, Osser, Schiff, & Smith, 1963). Therefore, the stimulus material was left intact.

The testing was done in two sessions, each session comprising the stimulus material from only one language. As described below, the order of presentation was counterbalanced across all subjects. In any half-day of testing, subjects from both grades were seen; within a given school, all subjects had received at least one session before any one given subject received the second session. Half of the subjects received the English session first; within a given grade, the language of the session alternated. On the average, the total testing time was one hour for the grade three subjects and forty minutes for the grade six subjects.

In order to avoid any systematic bias attributable to a fixed order of slides, the following procedure was followed. First, the shared word list was randomly divided in half and the words 'lion', 'test', 'pour', 'train', and 'strict' were assigned to the French session and the remaining words to the English session. Thus within one session, there were 55 stimulus words. The latter were randomly assigned to four different slide trays (A, B, C, D); there were 14 slides within each tray, except A which had 13. The order of the stimulus material for each tray is given in Appendix C. There are 24 possible permutations of the order of the trays; one permutation was randomly assigned to each subject for each language.

In each school, the equipment was set up in a separate room. The projector was placed on the desk where the child sat; the screen was 6' away from the subject. The experimenter was standing directly behind the projector and to the right of the subject. This enabled the experimenter to control the projector and to monitor the child's responses.

A child was taken from his classroom and brought into the separate room. The experimenter read him these instructions if he was being administered the English section:

> I'm going to flash some letters on the screen in front of you, very fast. The game is to see if you can read them. Sometimes they will spell a real English word, sometimes not. Read the letters and write them down as soon as possible after you have seen them. Before giving the flash, I'll say "Ready?" and you say "Yes". You watch the screen for the flash. Do you understand? ... Remember to pay attention. We'll do a few practice items first.

These instructions parallel those used by Gibson, Osser, and Pick (1963). In order to assure good comprehension, the main body of the French section instructions remained in English; only the underlined words in the text above were changed to their French equivalents.

The full instructions were read only when the child came for the first testing session. When the subject returned for the other half of the experiment, he was reminded briefly of the previous instructions and the experimenter stressed that this time, the letters would sometimes spell a real word in the other language. The practice items were not repeated unless many days had elapsed

between the first and second testing session. In order to induce an expectancy for one of the two languages, the experimenter spoke the language of that particular testing session.

Once the subject had indicated that he understood the instructions, he was given the five practice items: 'mental', 'ointp', 'faso', 'atch', 'bat'; the latter gave the subject a preliminary experience with words, pseudowords and nonwords. No feedback was given on the practice items, or on any subsequent items.

Before any slide was presented, the experimenter would say "Ready" and while the subject was looking up at the screen, the experimenter would manually activate the shutter. Then the child was given ample time to write down his response. Some subjects asked to be given the stimulus a second time because they had not seen the flash; this was due to inattention or a blinking eye movement. In every case, the experimenter agreed to the request; second presentations of the same stimulus were, however, a rare occurence (.6% of all stimulus presentations). At the end of each session, the experimenter checked the legibility of the written responses.

Design and Analysis

The experimental design is a repeated measures one. There are three repeated factors: Language (English, French), Type of spelling (typical, shared), and Structure (word, pseudoword, nonword); there is one group factor: Grade (three, six). All factors are crossed

and fixed, except subjects which is nested within grade and which is a random source of variation.

The dependent measure is the proportion of correct identifications; all proportions are based on 10 stimuli except the French and English shared word category which was based on the 5 stimuli used in that particular language session. No part scores were assigned since this a cumbersome procedure and it has not been shown to be useful (Gibson, Osser, & Pick, 1963).

The data was analyzed using the BMD 2PV analysis of variance program. The level of significance was set at $\alpha = .05$. Since there was some doubt as to whether the variance and covariance homogeneity assumption had been met, the Greenhouse-Geisser conservative F-test was applied to all main effects and interactions which were found significant (Kirk , 1968). The Scheffé post hoc procedure was used for all the multiple comparisons.

The SPSS Pearson correlation program provided correlation matrices between the different subsets of tasks for the grades combined and taken singly. An exact probability test (Guilford & Fruchter, 1973) was performed on each stimulus word by comparing the grade six and three on the proportion of correct identifications. The qualitative analysis sought to pick up interesting and consistent errors.

CHAPTER III

Results

In this chapter, the analyses of the different factors will be presented first, followed by the correlations found between the different types of stimuli. Next, the two grades will be contrasted on each individual stimulus used. The chapter will end with some comments about typical errors.

Anova and Multiple Comparisons

A four-way analysis of variance was performed. The means, standard deviations and anova table of this analysis are given in Appendix D. The most striking result of this analysis was that neither the main effect of type nor the two-way interaction of type x structure were significant. In trying to compare the shared and typical stimulus classification, the real word category may be ignored since not the same amount nor the same length of words are being contrasted. Likewise, the nonwords may be excluded since by definition they should not show the effect of the type classification. Concentrating on the pseudoword category, the grade three showed no effect of the type classification since the means were approximately equal for the shared and typical pseudowords in both English (.39, .37, respectively) and French (.54, .58, respectively). In grade six the results are somewhat more complicated.

In English, the grade six had superior performance on the typical pseudowords as compared to the shared pseudowords. Recalling that the typical pseudowords were derived by changing one letter in a real word whereas the shared pseudowords generally looked more unusual, this is not a surprising result. Looking at how well the individual pseudowords were handled within each type category, it can be seen that the six-letter shared pseudowords posed particular problems: 'profts' was almost invariably reported as 'profit' or 'profits' (this accounted for 11 out of 13 errors) and 'aspiwn' seemed like a very difficult pseudoword for even the grade six to handle. No comparable difficulties were found in the typical pseudowords. Bearing in mind that the grade six had very high accuracy scores and that there are only 10 stimuli per classification, it is evident that one or two words may bias the results for one given category.

In French, the grade six had the reverse trend, i.e., there was superior performance on the shared pseudowords as compared to the typical pseudowords. Again, the difficulty can be traced to two specific pseudowords. In the typical pseudowords, 'muit' and 'nilles' were generally transformed to 'nuit' and 'mille'; both errors are based on the confusability of 'm' and 'n'. No comparable difficulties occured in the shared category.

In view of the negative findings in the analysis of variance and of the difficulty encountered with certain stimulus items,

it was decided that the type factor should be eliminated by collapsing across the typical and shared categories. A three-way analysis of variance was again performed on the data, with two repeated measures (Language, Structure) and one group factor (Grade). As before, subjects are nested within grade and every other factor is crossed. The raw data for this analysis is presented in Appendix E. The means and standard deviations for the different groups are presented in Tables 1 and 2, respectively. The means are plotted on the graph of Figure 1.

Overall, the grade six sample had a 76% accuracy; for the English and French words, rare was the child that did not correctly report all ten. The stimuli ordered in the expected manner, i.e., means for words > pseudowords > nonwords, for both English and French. The variability was very low in grade six and was primarily due to the fact that the task was relatively easy for the grade six children. It is also possible that the grade six sample is a very homogeneous group.

For all stimuli, 40% were correctly recognized by the grade three sample. Again, the stimuli ordered in the expected manner, for both English and French. The variability was much higher in the grade three sample than in the grade six sample for the words and pseudowords but not for the nonwords. This can also be seen in the range of scores; for example, for the English word category the grade three range is .00 to 1.00 and the grade six range is

Table 1

Mean Proportion of Correct
Recognitions for Grade Six and Three

	Grade	
Language	Six	Three
English		
Words	.96	.50
Pseudowords	.83	.39
Nonwords	.47	.15
French		
Words	.95	.62
Pseudowords	.85	.56
Nonwords	.50	.19
Total	.76	.40

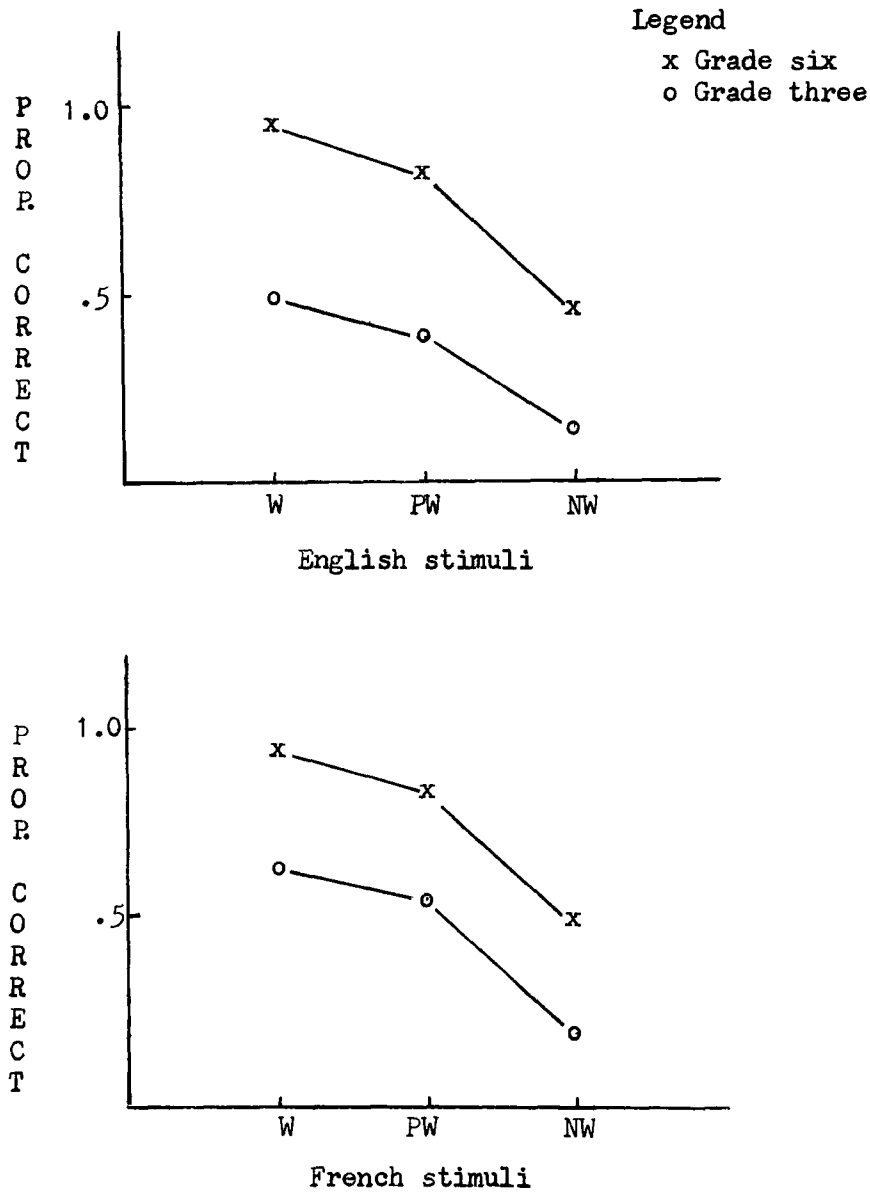
Table 2

Standard Deviations
for Grade Six and Three

	Grade	
Language	Six	Three
English		
Words	.07	.35
Pseudowords	.09	.30
Nonwords	.17	.15
French		
Words	.06	.29
Pseudowords	.10	.27
Nonwords	.16	.14

Figure 1

Mean Proportions for
Words (W), Pseudowords (PW), Nonwords (NW)



.73 to 1.00. The task was thus much more discriminating for the grade three students than for the grade six students. It is also possible that the group is more heterogeneous.

The results from the three-way analysis of variance are presented in Table 3. The Greenhouse-Geisser conservative F-test indicates that, except for the main effect of grade, all F values should be compared to the critical value of $\underline{F}_{.95}(1,36) = 4.17$. Thus, the significant sources of variance are: main effects of grade, language, and structure; two-way interaction of language x grade; three-way interaction of grade x language x structure.

Table 4 gives the results for the comparisons implied by the hypotheses stated in the first chapter; the means being compared have been given in Table 1. The Scheffé F values have been calculated by correcting the error mean square and the degrees of freedom (Kirk, 1968, p.300).

Referring to hypothesis one, an inspection of Figure 1 confirms that the grade six sample was consistently superior to the grade three sample on all tasks. The first set of contrasts in Table 4 reveals that the difference is indeed statistically significant.

Hypothesis two predicts that for the grade six, French and English will be on par. Since the nonwords are not relevant for this hypothesis, only words and pseudowords are examined. Table 4 clearly shows that the hypothesis is confirmed.

Table 3

Three-way Analysis of Variance
of the Factors Grade, Language and Structure

Source of Variation	SS	df	MS	F
Grade	7.28	1	7.28	42.38*
Error term	6.18	36	.17	
Language	.24	1	.24	23.70*
Language x Grade	.13	1	.13	13.40*
Error term	.36	36	.01	
Structure	7.75	2	3.88	155.65*
Structure x Grade	.07	2	.03	1.32
Error term	1.79	72	.02	
Language x Structure	.03	2	.02	2.99
Language x Structure x Grade	.05	2	.03	4.84*
Error term	.41	72	.01	

*significant at $p < .05$ for Greenhouse-Geisser conservative F

Hypothesis three implies that, due to the grade three's limited contact with English, French words and pseudowords should be better recognized than English ones. The means presented in Table 1 certainly suggest that this is the case and the difference is statistically significant (Table 4).

Hypothesis four and five deal with the use of structure in each language. In grade six, orthography is being actively exploited in both English and French (Table 4). This in the expected direction. Hypothesis five predicts that the grade three pupils are able to

Table 4

Scheffé F Values for
the Comparisons Implied by the Hypotheses
(numbers refer to the corresponding hypotheses)

	Contrast between	Constant level of other factors	Scheffé F
1.	Grade 6 & 3	English words	49.21*[a]
		English pseudowords	44.82*
		English nonwords	23.67*
		French words	25.63*
		French pseudowords	19.02*
		French nonwords	22.06*
2.	English & French	Grade 6 words	.01 [b]
		Grade 6 pseudowords	.06
3.	English & French	Grade 3 words	18.95*[b]
		Grade 3 pseudowords	39.84*
4.	Pseudowords & Nonwords	Grade 6 English	79.51*[c]
		Grade 6 French	73.87*
5.	Pseudowords & Nonwords	Grade 3 English	35.34*[c]
		Grade 3 French	83.53*
6.	Words & Pseudowords	Grade 6 English	11.18*[c]
		Grade 6 French	6.89*
7.	Words & Pseudowords	Grade 3 English	7.97*[c]
		Grade 3 French	2.21

* significant at $p < .05$

[a] Critical value $\underline{F}'_{.95}(1,216) = 3.04$

[b] Critical value $\underline{F}'_{.95}(1,108) = 3.92$

[c] Critical value $\underline{F}'_{.95}(2,144) = 6.08$

use the orthographic constraints in French but not in English. In fact, Table 4 shows that structure is being used in both languages, although the tendency appears somewhat weaker in English than in French.

Hypothesis six and seven stated that, since words are structured, familiar and meaningful, they should have an advantage over pseudowords which merely possess structure. For the grade six sample the effect was confirmed in both languages (Table 4). In the grade three sample, the phenomenon was restricted to English; in French, it would seem that words and pseudowords are on par (Table 4).

Correlation matrices

The correlation matrix for the combined grades yielded correlations in the range of .67 to .94, which were all significant. However, it was felt that the correlations were spuriously high since the two grades chosen represented extreme groups and no middle group had been included. Therefore, this correlation matrix is given in Appendix F.

The correlation matrices for the grade six and grade three are given in Tables 5 and 6, respectively. The correlation coefficients of interest are those involving the word and pseudoword categories.

For the grade six sample, the correlations between English words and French words and pseudowords were .66 and .45, respectively.

Table 5

Grade Six Correlation Matrix
for Words (W), Pseudowords (PW),
and Nonwords (NW) in English (E) and French (F)

	EW	EPW	ENW	FW	FPW	FNW
EW	-	.34	.33	.66***	.45*	.30
EPW		-	.62**	.56**	.42*	.52**
ENW			-	.39*	.60**	.77***
FW				-	.51**	.34
FPW					-	.67***
FNW						-

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 6

Grade Three Correlation Matrix
for Words (W), Pseudowords (PW),
and Nonwords (NW) in English (E) and French (F)

	EW	EPW	ENW	FW	FPW	FNW
EW	-	.89***	.55**	.91***	.86***	.48*
EPW		-	.73***	.92***	.90***	.55**
ENW			-	.65***	.54**	.50**
FW				-	.90***	.64**
FPW					-	.59**
FNW						-

*$p < .05$ ** $p < .01$ *** $p < .001$

For the same group, the correlations between English pseudowords and French words and pseudowords were .56 and .42, respectively. Considering the extremely low variability of the grade six group, it is surprising to find that all these correlations are significant.

The greater variability in the grade three sample assures optimum correlation coefficients. A glance at Table 6 shows that these coefficients are exceptionally high; all correlations are significant. No obvious abnormalities of the distributions can account for these results. For the grade three, the correlations between English words and French words and pseudowords were .91 and .86, respectively. The correlations between English pseudowords and French words and pseudowords were .92 and .90, respectively.

Because it is possible that such high correlations are due to the fact that both tasks correlate highly with a third variable, namely visual memory, it was decided to partial out the effect of English nonwords, since the latter can be considered a measure of the former (neither structure nor meaning interfere). Then the correlations between English words and French words and pseudowords become .95 and.80, respectively; the correlations between English pseudowords and French words and pseudowords become .94 and .88, respectively. These partial correlations are still statistically significant ($p < .001$).

Analysis of stimuli

For each grade, the number of correct recognitions for each stimulus item is given in Appendix G. Also indicated in Appendix G

is whether there is a significant difference between the grade six and grade three on the number of correct recognitions. The significance of the difference was determined by the exact probability test (Table M, Guilford & Fruchter, 1973); the significance level was set at .05.

A glance at Appendix G reveals that for all but two of the stimuli ('teux', 'nieux'), the grade six subjects did better than the grade three subjects, although the difference was sometimes minimal and did not always reach statistical significance.

For the four-letter words, there is no significant difference between the grade three and six except on such typical English words as 'know', 'down' and 'gift'; here the grade six is superior to the grade three. All five- and six-letter words are easily recognized by the grade six students and their performance is always significantly superior to the grade three students except on some typical French words ('noire' and 'filles').

All typical English pseudowords were better recognized by the grade six than the grade three. Only the word 'thriwn' seems to present a problem; this may be atributed to the fact that although 'i' followed by 'wn' is possible in English, it never occurs in a real word. For this same reason, the shared pseudoword 'liwn' has only moderate success with both grades. In the other shared pseudowords, the grade six is again significantly superior to the grade three, except for the very difficult pseudowords 'profts' and

'aspiwn'. As was the case with the French typical words, the French typical pseudowords do not show a marked superiority for the grade six group: only the pseudowords 'bieu', 'feure', and 'boeur' show a significant difference between the two groups. For the shared French pseudowords, the grade six regains a significant margin over the grade three: six out of ten pseudowords show a significant difference between the two groups.

The nonwords are of interest only insofar as any anomalies exist. Although for both groups, the percent correct drops off sharply when the five-letter nonwords are encountered, for the grade six, two exceptions are notable in the French shared category: 'eurst' (18 out of 19 correct) and 'ieusp' (13 out of 19 correct). If one considers that 'eu' is permissible in the initial position in both English and French and 'rst' is found in the final position in English words (e.g., 'first'), it would seem that 'eurst' did not seem to be a nonword for the subjects. The grade six students drew on their experience with English spelling patterns, and this in spite of the fact that they were being given the French section of the experiment. With the nonword 'ieusp', only the final 'sp' could have facilitated recognition and therefore the effect is less marked.

Qualitative Analysis

Looking at the actual responses given by the grade six and three students, one notices a moderate tendency to impose meaning on the pseudowords and nonwords. Thus, when faced with the four letters

'wnid', four grade six students reported the word 'wind'. In some cases, letters are transformed or added: 'ftog' was reported as 'flog', 'profts' as 'profit(s)', 'streng' as 'strength', 'esst' as 'east', etc. This tendency was much stronger for the grade six students than for the grade three students. Even when meaning could not be imposed, nonwords were made more structured by inserting vowels between the illegal strings of consonants or by the elimination of certain consonants. For example, 'oitp' was often reported as 'otip', 'enkst' as 'enkest', 'eunesl' as 'eunel' or 'eusel', etc. Although it is difficult to decide whether perceptual or response bias factors are responsible for these answers, these examples lend weight to the argument that the subjects were actively seeking and imposing structure. It may have been that the subjects were making hypotheses about what they should be seeing and providing this as their response.

CHAPTER IV

Discussion

In this chapter, some interpretations will be given to the results presented in the last chapter. The results will be discussed in the context of word perception experiments and bilingualism; the chapter will close with some considerations about the developmental aspects of the use of orthographic structure.

Word Perception

The present results agree well with those of other researchers who have used the total report method. Gibson, Osser, and Pick's (1963) grade three students had a 35% and 18% accuracy for four- and five-letter pronounceable and unpronounceable pseudowords, respectively; in the present study, the grade three immersion students had the following recognition accuracies: for French pseudowords and nonwords, 56% and 19%, respectively; for English pseudowords and nonwords, 39% and 15%, respectively. Using three- to nine-letter stimuli and a 33 msec exposure time, Gibson and Guinet (1971) obtained the following accuracy scores for adult subjects: 98% for real words, 83% for pronounceable pseudowords and 62% for unpronounceable pseudowords. Thus the grade six immersion students seem to be performing at a level close to that of adults since in English and French they obtain the following accuracy scores: English words, 96%, pseudowords, 83%, and nonwords, 47%; French words, 95%,

pseudowords, 85%, and nonwords, 50%. This agrees well with the conclusion drawn from the Lefton et al. (1973) experiment.

According to the rationale developed earlier, if orthographic structure is being used, then pseudoword recognition should be significantly more accurate than nonword recognition. Following this logic, it can be asserted that in grade six, orthographic structure is being actively exploited in both languages. It is not certain whether intraword redundancy is equally compelling in French and English, since frequency of letter clusters was not controlled across the two languages. However, the results for the particular stimuli used in this experiment suggest that the grade six immersion students perform at comparable levels in their two languages.

In grade three, orthographic structure is also been used in both languages but the disparity between pseudowords and nonwords is greater in French than in English. Considering that the children's formal education is mainly in French, the latter result is not surprising. The grade three immersion pupils evidence the same phenomenon in English in spite of limited contact with English reading.

Overall, the results indicate that the children are aware of the regularities of the language. This conclusion is confirmed by the qualitative analysis of the stimuli: the students have such strong expectations about permissible letter-strings that they insert vowels just as Spoehr and Smith's (1975) subjects were asked

to do; this phenomenon had already been noted by Gibson et al. (1962).

Although Baron and Thurston's (1973) forced-choice technique did not find a significant difference between words and pseudowords, experiments using the total report method have usually found a significant difference between words and pseudowords. Such a difference was not found in French for the grade three's words and pseudowords. This is a rather puzzling result: words supposedly have an advantage over pseudowords because of familiarity and meaning. Certainly, such simple French words are meaningful to the grade three students. It may be that because of French 'dictée', immersion classroom instruction insists as much on spelling patterns as it does on frequent contact with French words; however, without any data from the actual classrooms, this is but a guess. By grade six, words again would have an advantage over pseudowords if French reading was emphasized in the classroom curriculum.

Bilingualism

The prediction that pseudowords containing a shared spelling pattern should be better recognized than those composed entirely of typical spelling patterns was not confirmed. The assumption of the spelling pattern hypothesis can hardly be faulted since it has received such strong empirical support (Spoehr & Smith, 1975). It was supposed that since certain letter clusters occured in both languages, the child would have been exposed more often to these clusters than to those typical of each language; it may be that this

assumption is false. This could be empirically verified by tabulating the frequency of letter clusters in the French and English readers of the immersion pupils.

It was hypothesized that if little transfer occured between the immersion child's two languages, then the grade three pupils would not be using orthographic structure in English. That the grade three boys were performing at a level comparable to that of monolinguals (Gibson, Osser, & Pick, 1963) is not unexpected in view of the findings from different immersion programs (Swain, 1974). However, the testing was done in the first trimester of the school year: thus the students had only two or three months of English Language Arts. In grades one and two, comparable immersion children have generally been significantly behind their monolingual peers in reading (Edwards & Smyth, 1976). Thus, it may be inferred that in such a short time period, the children have made significant progress in abstracting patterns. However, since it was impossible to actually test grade one and two immersion classes, this is only inference. It may be that a "set for structure" (Gibson, 1970) enables the children to begin reading on their own. In fact, in the predominantly English milieu of Ottawa, the children would naturally be exposed to many written words (billboards, television ads, shop signs, etc.) and thus would have many occasions to induce the rules for themselves. And of course, there remains the strong possibility that appropriate English reading materials are available

in the home. Because the children's mother tongue is English, grapheme-to-phoneme correspondences would be easier to establish in English than in French.

Most grade three students were unfamiliar with spoken French before they entered the immersion program. Through classroom instruction, they have managed to become aware of French grapheme-to-phoneme correspondences. In fact, their formal training leads them to a better recognition of a French cluster such as 'uit' than of an English cluster such as 'kn'. Overall, they do better with the French pseudowords than with the English ones; there is less difference between the two grades on typical French pseudowords than on typical English ones. There thus may be three factors which contribute to success in this task: previous knowledge of the oral language, formal instruction in reading and frequency of exposure to specific patterns. In each of the immersion child's languages, there are differing amounts of each of these factors.

A capacity to induce regularities within and across languages may help explain the high correlations found between the grade three's performance in English and French. Tucker (1975) also found sizeable correlations for the grade one and two immersion classes; he interprets this as evidence for transfer of skills across languages. Exactly what skill is being transferred is not mentioned: in view of Gibson's (1970) convincing argument that children can be encouraged to look for invariant spelling patterns, this 'set for structure'

is part of the skill that is being used in both languages. Of course, specific elements which are common to both languages could also contribute to the 'transfer' effect (Cowan & Sarmed, 1976). Since in this particular experiment, both typical and shared patterns were used, the correlations probably reflect contributions from both factors.

Developmental Aspects

The development of the immersion child's acquisition of intra-word redundancy begins in grade one. Here the unilingual English child is faced with the oral and written form of the French word; he induces the regularities of correspondence between the two. He also probably becomes acutely aware of the arbitrariness of his first language (Ianco-Worrall, 1972); his contact with two languages encourages him to become a 'detective' in linguistic matters (Lambert & Tucker, 1972). Confronted with reading material in his own language, the immersion child applies his expectation for invariant spelling patterns to the words of his own language; furthermore, since he knows the syntax and the semantics of his native language and since he recognizes some words and spelling patterns as being similar to French ones, he can make informed guesses on certain words.

Success in abstracting English spelling patterns is highly correlated with performance on French spelling patterns. The child who has been unable to grasp the intraword redundancy of French will

not do much better once native language reading is introduced in grade three. By this grade most immersion children have reached a reasonable level of proficiency in using the orthography of both languages, although there are some notable exceptions (see Appendix E). They quickly make up any deficit which they may have had in their native language.

By grade six, performance in one language remains predictive of performance in the other language. By now, the pupils have reached adult-like levels of proficiency in using the orthographic constraints of each language. Efficiency on the word perception level means that the students are now free to pay more attention to syntax and semantics. Since they know the syntactic and semantic constraints of their native language, reading in English should present no problem; indeed the results of this immersion program has shown that at the end of grade three, the immersion children read as well as their monolingual peers (Edwards & Smyth, 1976). However, studies with young bilinguals (Cziko, 1977; Young & Williamson, 1976) seem to indicate that when bilingual students are reading in their weaker language, they are not sufficiently sensitive to the syntactic and semantic constraints of the second language. Certainly this research has shown that their problems in second language reading do not lie at the level of the orthographic constraints of the language.

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APPENDIX A

Rating Scales

English version

I am trying to determine whether certain clusters of letters occur more or less frequently in written English. Because you are familiar with the written language, please give me your assessment of how frequently the following clusters appear. Here are two examples:

1. At the beginning of a word (initial position), the combination 'tr' is: nonexistent, rare, or common. You could have marked 'tr' as frequent since it occurs in such common words as train, trace, tract, trait, etc.
2. At the end of a word (final position), the combination 'cque' is nonexistent, rare, or common. You could have marked 'cque' as never occuring in the English spelling because no word ends with these letters.

Therefore, judge each cluster of letters by generating examples or counterexamples. Think always about the written word. Do not let any other languages you know interfere with your assessment of these letter clusters.

Please also answer the following questions:
Mother tongue_____Other languages_____
I read: a) a great deal b) frequently c) rarely d) never

Thank you for your time and patience
xxxxxxxxxx

Mark an 'x' for your choice

In the initial position (no other letters precede)

	common	rare	nonexistent
1. 'kn'			
2. 'spr'			
3. 'thr'			
4. 'wr'			
5. 'sw'			
6. 'sn'			

In the final position (no other letters follow)

		common	rare	nonexistent
1.	'uit'			
2.	'wn'			
3.	'que'			
4.	'lles'			
5.	'sk'			
6.	'ss'			
7.	'oeur'			
8.	'ieu'			
9.	'mbe'			
10.	'lk'			
11.	'nq'			
12.	'ft'			
13.	'eux'			
14.	'eau'			
15.	'ng'			
16.	'ieux'			
17.	'll'			
18.	'eure'			
19.	'oire'			
20.	'fts'			
21.	'ien'			
22.	'ieux'			
23.	'ow'			
24.	'eur'			
25.	'ck'			
26.	'eunes'			
27.	'oir'			
28.	'nk'			
29.	'oit'			

French version

Je voudrais évaluer la fréquence de certaines combinaisons de lettres dans la langue écrite. Puisque vous connaissez le français, je voudrais obtenir votre évaluation sur la fréquence de ces groupes de lettres. Voici deux exemples:

1. Au début d'un mot (position initiale), le groupe 'tr' se voit: souvent, rarement, jamais. Vous auriez pu marquer 'tr' comme se voyant très souvent puisque on le retrouve dans toute une série de mots communs, tel train, trace, tract, trait, etc.
2. A la fin d'un mot (position finale), le groupe 'lfths' se voit: souvent, rarement, jamais. Vous auriez pu marquer 'lfths' comme étant inconnu dans la langue écrite puisque aucun mot français ne finit par cette combinaison de lettres.

Donc, jugez chaque groupe de lettres en pensant à des exemples. Tenez vous en toujours à la langue écrite. Si vous connaissez d'autres langues que le français, ne les laissez pas influencer votre évaluation de ces combinaisons de lettres.

Veuillez aussi répondre aux questions suivantes:
Langue maternelle _____ Autres langues_____
Je lis: a) très souvent b) assez souvent c) rarement d) jamais

Merci!

xxxxxxxxxx

Marquez votre choix par un 'x'

En position initiale (aucune lettre ne précède)

		souvent	rarement	jamais
1.	'kn'			
2.	'spr'			
3.	'thr'			
4.	'wr'			
5.	'sw'			
6.	'sn'			

En position finale (aucune lettre ne suit)

(the same list as in the English version)

APPENDIX B

Stimulus material

English Section

Typical spelling

Words	Pseudowords	Nonwords
know	kniw	wikn
down	diwn	wnid
gift	goft	ftog
wrong	wreng	ngewr
swing	swong	ngosw
snack	snick	ckisn
swell	swall	llasw
spring	sprong	ngospr
thrill	throll	llothr
thrown	thriwn	wnithr

Shared spelling

Words	Pseudowords	Nonwords
(lion)[a]	liwn	iwnl
(pour)	posk	oskp
(test)	tess	esst
blond	blull	ullbl
(train)	trock	ocktr
style	stenk	enkst
sport	spilk	ilksp
(strict)	streng	engstr
profit	profts	ftspro
aspect	aspiwn	iwnasp

[a] Words in parentheses were not given in the English section of the experiment but are included here to show the relationship with the corresponding pseudowords.

French Section

Typical spelling

Words	Pseudowords	Nonwords
nuit	muit	uitm
lieu	bieu	ieub
beau	jeau	eauj
heure	feure	euref
coeur	boeur	oeurb
mieux	nieux	ieuxn
noire	hoire	oireh
banque	canque	anquec
filles	nilles	illesn
jeunes	leunes	eunesl

Shared spelling

Words	Pseudowords	Nonwords
lion	linq	inql
pour	poit	oitp
test	teux	euxt
(blond)[a]	bluit	uitbl
train	troir	oirtr
(style)	steur	eurst
(sport)	spieu	ieusp
strict	streux	euxstr
(profit)	prombe	mbepro
(aspect)	aspien	ienasp

[a] Words in parentheses were not given in the French section of the experiment but are included here to show the relationship with the corresponding pseudowords.

APPENDIX C

Tray Order

English Section

Tray: A	B	C	D
wrong	ilksp	goft	gift
thrown	stenk	spring	wnithr
oskp	diwn	spilk	swell
esst	enkst	ullbl	swing
down	llothr	wnid	thrill
profts	llasw	ocktr	blond
kniw	ngosw	sport	wreng
liwn	engstr	ckisn	know
streng	profit	sprong	style
trock	iwnasp	snack	ngewr
blull	thriwn	throll	posk
swong	swall	ftog	wikn
aspiwn	snick	ngospr	iwnl
	ftspro	tess	aspect

French Section

Tray: A	B	C	D
train	feure	oitp	canque
linq	eunesl	lion	uitbl
lieu	uitm	nieux	teux
boeur	anquec	pour	ieub
euref	jeau	nuit	banque
oeurb	ienasp	inql	bluit
eauj	euxstr	leunes	steur
nilles	test	oirtr	hoire
filles	jeunes	noire	coeur
prombe	ieusp	mbepro	muit
euxt	beau	mieux	aspien
bieu	strict	ieuxn	heure
troir	spieu	poit	oireh
	eurst	streux	illesn

APPENDIX D

Results of Four-Factor Analysis of Variance

Mean proportion of correct recognitions

(standard deviations are shown in parentheses)

	Grade	
Language	Six	Three
English		
Typical spelling		
Words	.97 (.06)	.54 (.35)
Pseudowords	.89 (.08)	.38 (.34)
Nonwords	.47 (.17)	.15 (.16)
Shared spelling		
Words	.94 (.15)	.42 (.38)
Pseudowords	.76 (.15)	.39 (.27)
Nonwords	.46 (.21)	.15 (.15)
French		
Typical spelling		
Words	.95 (.07)	.59 (.33)
Pseudowords	.82 (.13)	.58 (.30)
Nonwords	.49 (.19)	.19 (.17)
Shared spelling		
Words	.96 (.08)	.68 (.22)
Pseudowords	.87 (.15)	.54 (.26)
Nonwords	.50 (.17)	.19 (.13)

Summary Table of Anova

Source	SS	df	MS	F
Grade (G)	14.60	1	14.60	43.15*
Error term	12.18	36	.34	
Language (L)	.59	1	.59	28.23*
L x G	.33	1	.33	15.62*
Error term	.75	36	.02	
Type (T)	.02	1	.02	1.10
T x G	.00	1	.00	-
Error term	.65	36	.02	
L x T	.14	1	.14	12.94*
L x T x G	.00	1	.00	-
Error term	.39	36	.01	
Structure (S)	15.38	2	7.69	160.60*
S x G	.14	2	.07	1.42
Error term	3.45	72	.05	
L x S	.07	2	.03	2.58
L x S x G	.13	2	.07	5.16*
Error term	.93	72	.01	
T x S	.02	2	.01	.83
T x S x G	.01	2	.00	.32
Error term	.71	72	.01	
L x T x S	.07	2	.03	2.41
L x T x S x G	.21	2	.11	7.32*
Error term	.04	72	.01	

* $p < .05$ for Greenhouse-Geisser conservative F-test

APPENDIX E

Raw Data for Three Factor Analysis

Grade Six

English			French		
Word	Pseudoword	Nonword	Word	Pseudoword	Nonword
1.00	.75	.25	.93	.65	.15
1.00	.85	.60	1.00	1.00	.65
.93	.90	.30	1.00	.75	.40
.93	.95	.65	1.00	.90	.60
.93	.85	.60	.93	.80	.55
1.00	.75	.35	1.00	.90	.55
1.00	.85	.70	1.00	.90	.65
1.00	.95	.45	1.00	.85	.65
1.00	.90	.85	1.00	.95	.75
1.00	.70	.30	1.00	.85	.35
.75	.70	.30	.80	.65	.35
1.00	.85	.50	.93	.85	.45
.93	.80	.30	.93	.85	.15
.93	.65	.35	.80	.80	.50
1.00	.85	.40	.93	.75	.55
1.00	.80	.45	1.00	.95	.60
1.00	.95	.60	.93	1.00	.65
1.00	.85	.55	1.00	.80	.45
.87	.80	.35	.93	.90	.50

Grade Three

English			French		
Word	Pseudoword	Nonword	Word	Pseudoword	Nonword
.33	.30	.20	.53	.40	.25
.60	.50	.10	.73	.75	.15
.80	.70	.05	.67	.90	.15
.67	.50	.20	.80	.80	.20
.20	.20	.05	.47	.50	.15
.80	.50	.20	.87	.75	.25
.33	.05	.00	.40	.40	.00
.73	.40	.10	.73	.55	.30
.73	.75	.25	.93	.70	.05
.33	.50	.15	.73	.60	.40
.93	.75	.25	1.00	.90	.25
1.00	1.00	.65	1.00	.95	.40
.13	.10	.10	.27	.20	.00
.87	.60	.20	1.00	.75	.45
.00	.00	.05	.27	.20	.10
.07	.00	.00	.07	.05	.00
.87	.40	.05	.67	.60	.20
.00	.05	.05	.33	.50	.30
.13	.05	.15	.33	.15	.05

APPENDIX F

Correlation Matrix for Grades Three and Six Combined (n = 38)

	EW	EPW	ENW	FW	FPW	FNW
EW	-	.93***	.70***	.94***	.89***	.67***
EPW		-	.80***	.94***	.90***	.74***
ENW			-	.72***	.70***	.83***
FW				-	.91***	.71***
FPW					-	.72***
FNW						-

*** $p < .001$

APPENDIX G

Recognition Scores for Individual Stimulus Items

English Section

Typical Spelling

Stimulus Item	Grade Six	Grade Three	
know	18	11	*
down	19	14	*
gift	19	11	**
wrong	18	10	**
swing	19	12	**
snack	19	11	**
swell	19	13	*
spring	18	10	**
thrill	17	8	**
thrown	19	3	**
kniw	17	4	**
diwn	17	9	*
goft	19	10	**
wreng	18	5	**
swong	17	10	*
snick	18	10	**
swall	18	9	**
sprong	17	8	**
throll	16	6	**
thriwn	13	1	**
wikn	18	6	**
wnid	13	4	**
ftog	15	8	*
ngewr	10	1	**
ngosw	6	3	
ckisn	6	1	
llasw	11	4	*
ngospr	5	0	*
llothr	3	0	
wnithr	2	0	

Shared Spelling

Stimulus Item	Grade Six	Grade Three	
(lion)[a]	19	18	
(pour)	18	17	
(test)	19	17	
blond	19	12	**
train	19	10	**
style	18	6	**
sport	17	10	*
(strict)	16	3	**
profit	18	7	**
aspect	17	5	**
liwn	15	12	
posk	19	13	*
tess	19	13	*
blull	16	5	**
trock	19	10	**
stenk	15	7	*
spilk	15	7	*
streng	14	5	**
profts	6	3	
aspiwn	6	2	
iwnl	15	4	**
oskp	15	6	**
esst	13	10	
ullbl	8	1	*
ocktr	8	1	*
enkst	11	5	
ilksp	7	0	**
engstr	4	1	
ftspro	3	0	
iwnasp	4	0	

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

[a] These items were not actually given in the English section.

French Section

Typical Spelling				Shared Spelling			
Stimulus Item	Grade Six	Three		Stimulus Item	Grade Six	Three	
nuit	19	15		lion	19	18	
lieu	19	15		pour	18	17	
beau	19	16		test	19	17	
heure	18	11	*	(blond)[a]	19	12	**
coeur	19	11	**	train	19	10	**
mieux	19	10	**	(style)	18	6	**
noire	17	12		(sport)	17	10	*
banque	18	11	*	strict	16	3	**
filles	17	11		(profit)	18	7	**
jeunes	16	6	**	(aspect)	17	5	**
muit	14	12		linq	19	10	**
bieu	19	14	*	poit	18	17	
jeau	17	11		teux	18	19	
feure	19	9	**	bluit	15	12	
boeur	18	10	**	troir	18	12	*
nieux	15	16		steur	18	9	**
hoire	16	10		spieu	17	9	*
canque	16	10		streux	16	4	**
nilles	10	10		prombe	18	7	**
leunes	13	8		aspien	8	4	
uitm	8	4		inql	15	7	*
ieub	19	11	**	oitp	11	8	
eauj	16	2	**	euxt	19	13	*
euref	12	5	*	uitbl	5	0	*
oeurb	7	2		oirtr	7	2	
ieuxn	11	4	*	eurst	18	6	**
oireh	7	4		ieusp	13	3	**
anquec	10	1	**	euxstr	3	0	
illesn	2	0		mbepro	1	0	
eunesl	1	2		ienasp	4	0	

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

[a] These items were not actually given in the French section.