The Influence of the Phonological Characteristics of a Language on the Functional Units of Reading: A Study in French

MARCUS TAFT *University of New South Wales, Sydney, Australia*
MONIQUE RADEAU *Free University of Brussels, Brussels, Belgium*

Abstract Taft (1992) reported results supporting the idea that the "Body of the BOSS" (BOB) is an important unit in the visual recognition of English polysyllabic words. "BOSS" refers to the orthographically-defined first syllable of a word (e.g., the *lam* of *lament);* "Body" refers to the part of that syllable which follows the initial consonant(s) (e.g., the *am* of *lam).* The primary evidence supporting this notion was that the pronunciation of an ambiguously pronounceable nonword could be biased by the pronunciation of a preceding word when they shared their BOB, but not when they shared their phonologically-defined first syllable. Three experiments were conducted in French, to examine whether the syllable dominates as a unit of orthographic representation when the language has a clear phonological syllable structure. To construct ambiguously pronounceable nonwords, upper case letters were used and the first syllable always contained an E, which could be pronounced either as *é* or *e.* Nonwords (e.g., MERANE) were preceded by an upper case version of a word sharing a BOB (e.g., *féroce)* or a first syllable (e.g., *méduse).* The pronunciation of the nonword's E was biased by the syllable and not by the BOB, implying that the syllable, but not the BOB, is a relevant structure in the processing of visually presented French words.

What are the functional units of reading an alphabetically written word? Is the letter-string recognized purely on the basis of recognition of the individual letters, or are the letters organized into larger processing units that are nevertheless smaller than the whole-word? A morpheme is one such possible unit (e.g., Taft, 1994), but so are other units below the morpheme level. For example, the letter-string *picnicking* can be processed as the morpheme units *picnic* and *ing;* but *picnic* can be analysed further into the syllabic units *pic* and *nic* and these syllables could be analysed further still into subsyllabic units (e.g., in processing the ic of both *pic* and *nic).*

There has been considerable interest in recent years in the involvement of subsyllabic units in reading. Most of the research has examined English

Canadian Journal of Experimental Psychology, 1995, 49:3, 330-346

monosyllabic (monomorphemic) words, and comes to the conclusion that such words are mentally structured in terms of their onset and body during lexical processing (e.g., Bowey, 1990; Kay & Bishop, 1987; Taraban & McClelland, 1987; Treiman & Chafetz, 1987; Treiman, Goswami, & Bruck, 1990; Treiman & Zukowski, 1988). The onset/body structure divides the orthographic representation of a monosyllable between its initial consonant or consonant cluster and its vowel. For example, *red* has an onset r and a body *ed, stripe* has an onset *str* and a body *ipe,* and *priest* has an onset *pr* and a body *iest.* Thus, "body" refers to the orthographic equivalent of the phonological "rhyme" (or "rime") of the word (e.g., Fudge, 1987). In this way, *priest* and *least* have different bodies (i.e., *iest* and *east* respectively), but the same rhyme (i.e., /i:st/). The body is itself composed of a vowel (e.g., the *ie* of *priest)* plus the final consonants, or "coda" (e.g., the *st* of priest).

Taft (1992) has extended the notion of onset/body structure to bisyllabic words. What he proposes is that each syllable of the orthographic representation of a word has its own onset/body structure and that it is the combined activation of lexical units representing these onsets and bodies that allows the word to be recognized. For example, the word *kidney* has two syllables, *kid* and *ney* made up of *k* plus *id* and *n* plus *ey* respectively. Taft therefore proposes that the word *kidney* would be activated in the lexical processing system via a representation of the units *k, id, n,* and *ey.* If this is the appropriate way to extend the notion of onset/body structure from monosyllabic words to bisyllabic words, the major issue then becomes where the syllable boundary falls.

In English, the positioning of the syllable boundary is by no means clear-cut. When a word has a short vowel followed by a single consonant, as does *lemon*, the syllable boundary might fall after the consonant (giving *lem+on*[1], e.g., Pulgram, 1970) or the consonant might be assigned to both syllables making it ambisyllabic (giving *lem+mon*, e.g., Anderson & Jones, 1974; Kahn, 1976). Similar uncertainties arise when there is a medial consonant cluster (e.g., is it *thun+der*, *thund+der*, or even *thund+er*?), and also when the vowel is long (e.g., is it *de+mon*, *dem+mon*, or *dem+on*?). Even with examples like *kidney*, one could possibly argue that the *d* is actually ambisyllabic, despite the fact that the second syllable would then begin with the cluster dn whose pronunciation never occurs intra-syllabically in English. The situation which provides the least controversial case in English is where stress falls on the second syllable (e.g., *lament*). All phonological theories appear to agree that the boundary must fall between the first vowel and the medial consonant (giving *la+ment*).

1 Linguistic theories of syllabification focus on the syllabification of spoken words. The concern here, however, is the orthographic counterpart of such syllabification. For this reason, examples will be presented in orthographic rather than phonological form.

Given this general difficulty in English of defining what the syllable structure of all words is, Taft (1979, 1986, 1987, 1992) put forward the idea of an orthographically defined syllable, called the Basic Orthographic Syllabic Structure (or BOSS). Focusing on the first syllable only, the BOSS can be seen as essentially following the orthographic equivalent of a "principle of maximal coda". That is, the BOSS includes all consonants following the first vowel which can occur within the coda of a syllable. So, the BOSS of *thunder is thund,* the BOSS of *demon is dem,* and most importantly for current concerns, the BOSS of *lament is lam.* The BOSS therefore serves to maximize the informativeness of the first syllable, which is claimed to be the most important unit in visual word recognition (e.g., Taft & Forster, 1976), by including as many letters as are permissible within that syllable.

The claim that each syllable of a bisyllabic word has its own onset/body structure is therefore equivalent to the claim that the BOSS is broken down further into its onset and body. For example, the *lam* of *lament* would be broken down into its onset *l* and its body *am.* To support this position, Taft (1992) reported an experiment which examined whether the pronunciation of a nonword could be biased by the pronunciation of a preceding word which shared its "body of the BOSS" (or BOB) rather than by that of one which shared its first phonologically defined syllable (or PS). To differentiate the PS and the BOSS clearly, the priming words that were used were all instances with stress on their second syllable (like *lament,* whose PS is *la* and whose BOB is *am).* The nonwords were all bisyllabic and could be pronounced with stress either on their first or second syllable (e.g., *camulk).* Taft's study demonstrated that stress was placed on the second syllable of the nonword more often when preceded by a prime that had the same BOB (e.g., *lament camulk)* than when preceded by a prime that had the same PS (e.g., *cavort camulk).* In fact, the PS condition did not differ from a control condition where the prime word and target nonword had nothing in common (e.g., *divert camulk).* It was therefore apparent that the body of the BOSS has a status in lexical processing that the phonologically-defined first syllable has not.

Now, one of the justifications for the existence of a BOSS-type unit is the fact that it circumvents the uncertainty of where phonologically-defined syllable boundaries fall. There are languages, however, for which there is little or no uncertainty about the phonological syllabic structure and, therefore, the rationale for the existence of BOSS's in such languages is greatly weakened. If it can be shown in these languages that it is the PS rather than the BOB that is a lexical processing unit, this will provide a clear contrast with English and thus demonstrate the influence of the linguistic characteristics of a language on the cognitive mechanisms adopted in reading. The experiments to be reported here examine this issue by using a task similar to that used by Taft (1992), comparing BOB's and PS's in a language for which the phonological syllabic structure is relatively well-defined. Such a language is French.

In French, a bisyllabic word is always stressed (or more correctly, "accented") on its second syllable, and as such, a medial VCV (vowel-consonant-vowel) structure will always be syllabified after its first V in the same way as lament is in English. Thus, the syllable structure is unambiguous for all VCV bisyllabic French words (e.g., *bi+jou, mé+duse, sau+ter).*

The fact that French syllabic structure is considerably less ambiguous than English syllabic structure has been demonstrated to be relevant in the processing of spoken words (Cutler, Mehler, Norris, & Segui, 1986; Mehler, Dommergues, Frauenfelder, & Segui, 1981). What was shown by Mehler et al. was that target letter strings (CV or CVC) were detected more quickly by French speakers at the beginning of spoken French words when they coincided with the first syllable than when they did not, whereas Cutler et al. (1986) observed that English speakers did not show such an effect with English words. What is of interest here, however, is whether the difference that exists between French and English in the clarity of their phonological syllable structure is reflected in the way in which visual lexical processing takes place.

Experiment 1

The experiment by Taft (1992) looked at the biasing of the pronunciation given to a bisyllabic nonword when preceded by a bisyllabic word which either shared a BOB, shared a phonologically-defined first syllable, or had nothing in common. The word prime was always stressed on its second syllable; the question was whether the nonword target would also be given stress on its second syllable. Unfortunately, exactly the same paradigm cannot be adopted in French: Nonwords would always be accented on their second syllable because French bisyllables are always pronounced in this way. To set up a situation where a bias in nonword pronunciations can be observed requires the creation of nonwords which could be given more than one pronunciation. The way this was achieved in the following experiments was to exploit the fact that when French words are written in upper case letters, the diacritics used to differentiate *é, è, ê* and *e* are excluded. For example, the words *règle* (meaning "rule") and *réglé* (meaning "regular") are written the same way when in upper case letters (i.e. REGLE). As a result of this, the pronunciation of an unknown letter-string is sometimes ambiguous if it includes an E and is presented in upper case. This is the case in polysyllabic items with a CV first syllable (in an initial CVCV structure), containing E as vowel. For example, the nonword MERANE could be pronounced as if it were either *mérane* (i.e., /mera:n/) or *merane* (i.e., /m ə ra:n/).

Given this means of creating ambiguous nonwords, it is now possible to find word primes which share either a BOB, a PS, or nothing with the nonword target. FEROCE (the upper case version of *féroce)* has the same BOB as

MERANE, and therefore, if the BOB is an important unit in French as it appears to be in English, FEROCE as a prime should bias the pronunciation of the first E of MERANE toward the /e/ pronunciation (i.e., treating it as an *é)* to a greater degree than will a completely unrelated prime like SALAUD. On the other hand, if the phonological syllable is the important unit, the word MEDUSE (the upper case version of *méduse*) should be the more effective prime for biasing the pronunciation of the E of MERANE toward /e/, because the prime and target share a PS.

METHOD

Subjects

Forty-eight subjects, students at the Free University of Brussels, participated in the experiment as part of an introductory Psychology course. They were divided into three groups of 16 subjects and tested with one of three lists of items. All were native speakers of French.

Materials

The experimental items were prime/target pairs where the prime was a word and the target was a nonword of equal length. The nonwords were 42 bisyllabic letter-strings with an initial structure of CVCV, where the first V was always the letter E. The medial consonant of the nonword was never a digraph *(ch, go, qu,* geminate consonant, etc), and the last bigram or trigram was always a possible ending in French (Content & Radeau, 1988). An attempt was made to use CVC's whose E existed in French as both *e* or *é.* For example, the MER of MERANE exists both with an *e* (e.g., *meringue)* and with an *é* (e.g., *mérite).* In some cases, however, the first CVC did not exist with either of the two forms of E, or only existed with the form of E that did not occur in the word prime. For example, SEN in a CVCV word is always *sén* (e.g., *sénat)* and never *sen.* It was nevertheless used at the beginning of a nonword (i.e., SENOU), but was preceded by a word designed to prime the *e* pronunciation (i.e., *tenue* or *selon).*

To make sure that there was plenty of opportunity for the primed pronunciation to reveal itself, the nonwords were tested in a preliminary experiment where they were mixed with word fillers whose first vowel was never the letter E. Those already giving rise to the primed pronunciation more than 50% of the time were not included as experimental nonwords.

The words that were used as primes were 126 non-prefixed, bisyllabic words. There were three word prime conditions, with 42 words per condition. All of the items for all of the experiments are shown in the Appendix.

1. PS Condition: Here the first consonant and vowel matched with those of the paired nonword target (e.g., MEDUSE MERANE). For half of the words, the E represented an *é* (as in *méduse);* for the other half it represented an *e* (as in *petit,* the PS prime for the nonword PENOS).

2. BOB Condition: Here the first vowel and second consonant matched with those of the paired nonword target (e.g., FEROCE MERANE). For half of the words, the E represented an *é* (as *in féroce);* for the other half it represented an *e* (as in *mener,* the BOB prime for PENOS).

3. Control Condition: Here the letters in the word differed as much as possible from the paired nonword and, most importantly, the first vowel was never an E (e.g., SALAUD MERANE, FUSIL PENOS).

The average word frequency for each condition was 5.0 per million calculated in BRULEX (Content, Mousty, & Radeau, 1990) from the textual frequencies for printed words given in Trésor de Langue Française (1971).

For a word or nonword to be presented only once to each subject, three lists of items were constructed. Each list contained 14 nonwords each immediately preceded by a word with the same BOB (7 with *e* and 7 with *é),* 14 preceded by a word with the same syllable (7 with *e* and 7 with *é)* and 14 preceded by a control word. These 84 items (42 words plus 42 nonwords) were mixed with 56 filler items, giving rise to 140 trials in a session. The fillers consisted of bisyllabic words and nonwords with the same structure as the experimental items but without *e* or *é* as their first vowel. The order of presentation was randomized except for the fact that a prime word always immediately preceded its nonword target pair. Twenty-four other bisyllabic items (half words and half nonwords) served as practice trials.

Procedure

The items were presented in upper-case letters on the screen of an APPLE IIe computer. A trial consisted of a fixation point (+) presented for 100 ms, followed by a 200 ms blank and then by the stimulus which lasted 1200 ms. The stimulus was centered on the screen, and the fixation point was presented two character spaces above the center of the target. The ISI was 1500 ms. Subjects were instructed to read aloud each item, and if the item was a nonsense word, to give it the first appropriate pronunciation they thought of. The responses were monitored by the experimenter who noted the *e* or *é* pronunciation of the critical vowel, or the phonemic transcription in cases where an error of pronunciation was made. The responses were also recorded on tape for double-checking by a second individual. Both of the individuals who monitored the pronunciations were naive to the aim of the experiment.

RESULTS AND DISCUSSION

The number of times that the first vowel of the experimental nonword was pronounced in the same way as the preceding word of the BOB or syllable condition was calculated for each subject and each item. The percentage of congruent responses in each condition was calculated by dividing the number of congruent responses by the total number of *e* plus *é* responses, errors being discarded. In the control conditions, the critical score was the percentage of

TABLE 1
Proportion of nonword responses biased towards the pronunciation of the first vowel of the priming word for the BOB, PS and Control Conditions of Experiment 1. Intersubjects standard deviations are given in parenthesis.

	BOB	PS	Control	BOB-Control Difference	PS-Control Difference
é responses	39.6 (23.2)	42.8 (25.5)	33.9 (22.4)	5.7	8.9
e responses	50.5 (26.8)	57.7 (23.0)	44.8 (28.6)	5.7	12.9
Mean	45	50.3	39.4	5.7	10.9

pronunciations of the first vowel of the nonword that would have been expected for that nonword under the BOB and PS Conditions. For example, the score given to MERANE, whether it was preceded by FEROCE (BOB), MEDUSE (PS), or SALAUD (Control), was always the proportion of é pronunciations, while the score for PENOS, whether it was preceded by MENER (BOB), PETIT (PS), or FUSIL (CONTROL), was always the proportion of *e* pronunciations. The results are presented in Table 1.

The data were submitted to Analyses of Variance (ANOVAs), with Condition (PS, BOB, Control) and Vowel-Type (e, é) as factors.

The effect of Condition was significant ($F1(2,94) = 9.57$, $MS_e = 270.9$, $p < .001$; $F2(2,80) = 5.39$, $MS_e = 230.3$, $p < .01$). Analyzing this further, the data revealed a significantly greater proportion of biased responses in nonwords for the PS Condition compared to the Control Condition ($F1(1,47) = 21.85$, $MS_e = 237.3$, $p < .001$; $F2(1,40) = 8.62$, $MS_e = 287.3$, $p < .001$), as well as compared to the BOB Condition, though this was marginal ($F1(1,47) = 4.02$, $MS_e = 315.1$, $p < .05$; $F2(1,40) = 3.70$, $MS_e = 204.1$, $p < .10$). The BOB and Control Conditions were only significantly different in the subject analysis ($F1(1,47) = 5.10$, $MS_e = 260.3$, $p < .05$; $F2(1,40) = 2.48$, $MS_e = 199.4$, $p > .10$).

There was a greater tendency for the response to be given as *e* in the *e*-biasing conditions than it was to be given as *é* in the *é*-biasing conditions but this tendency was only significant in the subject analysis ($F1(1,47) = 4.46$, $MS_e = 2{,}384.3$, $p < .05$; $F2(1,40) = 3.13$, $MS_e = 1{,}566.0$, $p < .10$). More importantly, Vowel-Type did not interact with the Condition effects (all F's < 1).

These results are quite different to the comparable results obtained by Taft (1992) in English. Here, in French, it appears to be the phonological syllable structure that plays a role in visual lexical processing. The body of the BOSS shows a tendency toward having an impact on processing, but not as much as

TABLE 2
Proportion of nonword responses biased towards the pronunciation of the first vowel of the priming word for the BOB, Vowel and Control Conditions of Experiment 2. Intersubjects standard deviations are given in parenthesis.

	BOB	Vowel	Control	BOB-Control Difference	Vowel-Control Difference
é responses	42.7	43.3	42.3	0.3	1
	(24.6)	(30.1)	(22.9)		
e responses	45	41.3	40	5	1.3
	(27.5)	(26.8)	(26.9)		
Mean	43.8	42.3	41.2	2.7	1.2

the phonological syllable, whereas the latter had no influence at all in English.

Even if it turns out that the slight effect shown by the BOB Condition was genuine, it is possible that it arises from some unit other than the BOB. The most obvious possibility is that the vowel alone makes some contribution to the bias effect. For example, it may be the mere fact that the first E of FEROCE is an *é* that leads to the first E of MERANE being pronounced as an *é* as well. To assess this possibility, a second experiment again looked at the bias in pronouncing the first E of nonwords, but this time compared the BOB Condition to a Vowel Condition where the word prime and the nonword target shared only their first E (e.g., REGIME MERANE).

Experiment 2

METHOD

There were 48 new subjects, fulfilling the same criteria as in the first experiment. The materials and procedure were the same as in Experiment 1 except that a Vowel Condition was substituted for the PS Condition. The substitution was carried out, where possible, by re-pairing the word primes that were used in the PS Condition of Experiment 1 with different nonwords in the list, or otherwise by using a new word prime with the same structure and number of letters as its corresponding nonword target.

RESULTS AND DISCUSSION

As can be seen from Table 2, the proportion of nonword responses biased towards the pronunciation induced by the words of the BOB or Vowel Conditions was little different to the Control Condition. ANOVAs run on proportion of congruent responses did not give rise to any effect, with all *F*'s being close to zero. Half the subjects (24) showed a greater proportion of biased responses in the BOB condition compared to the Control, 21 subjects a weaker proportion and three subjects, the same proportion. The proportion of biased responses was greater in the Vowel condition than the Control for 26 subjects and weaker for 22.

TABLE 3
Proportion of nonword responses biased towards the pronunciation of the first vowel of the priming word for the PS, Vowel and Control Conditions of Experiment 3. Intersubjects standard deviations are given in parenthesis.

	PS	Vowel	Control	PS-Control Difference	Vowel-Control Difference
é responses	47.7	38.8	37.8	9.9	0.9
	(28.8)	(22.8)	(22.8)		
e responses	48.7	39.8	39.4	9.3	0.3
	(28.1)	(30.2)	(29.7)		
Mean	48.2	39.3	38.7	9.6	0.6

There was also no suggestion in the data that an *e* response was given in the *e*-biasing conditions to a greater degree than an *é* response was given in the *é*-biasing conditions, $F < 1$. Therefore, the tendency for a Vowel-Type effect that was observed in Experiment 1 was not sustained here.

More importantly, the results of Experiment 2 confirm the weakness of the BOB effect observed in Experiment 1. The item analysis comparing the BOB and Control Conditions was not significant in Experiment 1, and in Experiment 2, neither was the subject analysis. So, there appears to be nothing special about the BOB in French (for French speakers at least), which makes processing of that language very different to processing English where Taft (1992) has demonstrated clear effects of the BOB. Instead, Experiment 1 suggests that it is the phonological syllable that influences what the important units are in visual word processing; it is the syllable, and not just the vowel, according to the lack of a vowel effect in Experiment 2. To confirm this, Experiment 3 was conducted to examine the remaining combination of conditions, namely, PS versus Vowel versus Control.

Experiment 3

METHOD

There were 48 new subjects fulfilling the same criteria as used in the other two experiments. The materials and procedure were the same as in Experiment 1 except that a Vowel Condition was substituted for the BOB condition. The substitution was carried out, in most cases, by re-arranging the inducing words of the BOB Condition or, when this was not possible, by using other inducing words with the same structure and number of letters as the corresponding experimental nonword.

RESULTS AND DISCUSSION

ANOVAs revealed a significant effect of Condition ($F1(2,94) = 6.91$, $MS_e = 408.0, p < .001$; $F2(2,80) = 4.16$, $MS_e = 256.5, p < .05$). As can be seen from Table 3, in the PS Condition, the proportion of nonword responses biased towards the pronunciation induced by the preceding word was close to that obtained in Experiment 1. The PS and control conditions were significantly different in both the subject and item analyses ($F1(1,47) = 8.89$, $MS_e = 454.9$ $p < .001$; $F2(1,40) = 7.39$, $MS_e = 266.9$, $p < .001$). On the other hand, the vowel had no more influence than in Experiment 2. There was no effect of the Vowel Condition relative to the Control, with both $F1$ and $F2$ close to zero. In addition, the PS Condition showed significantly greater bias than the Vowel Condition ($F1(1,47) = 11.11$, $MS_e = 396.7$, $p < .001$; $F2(1,40) = 4.89$, $MS_e = 226.7$, $p < .05$). The effect of Vowel-Type was also nonsignificant ($F < 1$), as in Experiment 2 (suggesting that the Vowel-Type effect that was significant in the subject analysis of Experiment 1, but not in the item analysis, simply arose randomly from a few of the items in that experiment).

Experiment 3, then, confirms the results of the previous experiments that one can bias the pronunciation of the ambiguous vowel of a nonword only when that vowel occurs in the same first syllable of the prime word in French.

General Discussion

It is clear from the three experiments reported here that, in French, it is the phonological first syllable, rather than the first vowel alone or the body of the BOSS, which remains active after the word has been recognized. One way to interpret this, following the approach taken by Taft (1992), is to suggest that the phonological syllables of words are represented by orthographic units in lexical memory which are activated in the process of activating a lexical representation of a visually-presented word (e.g., *méduse* being represented by *mé* and *duse).*

A framework for thinking about lexical processing in this way is offered by Taft (1991, 1994) and Taft and Zhu (1994) whereby orthographic (and phonological) units are hierarchically represented, with activation passing up from grapheme (letter) units, through submorphemic units, morpheme units and then to whole-word units. What is being suggested here is that the submorphemic level is where English and French differ, English being represented by BOB's and French by phonologically-defined syllables. Thus the nature of the orthographic units is determined by the phonological characteristics of the language being represented. However, such an account is not the only interpretation that can be given to the present results.

For English, Taft proposed that the bias observed in nonword pronunciations induced by the BOB, but not by the phonological first syllable, arose from lingering activation in BOB units which had been activated in the course of processing the priming word. The fact that the BOB is not a pronunciational unit suggested that the biasing effect did not arise from the pronunciation of the word as generated from lexical memory for the purposes of naming the letter-string. However, the present French study, which demonstrated the importance of a phonological unit, could be interpreted in such post-access terms. That is, after a word is uttered, a trace of that utterance remains in working memory, and can serve to bias the decision of how to pronounce a subsequent nonword which has an ambiguous pronunciation. When one of the possible pronunciations of part of that nonword coincides with something remaining in working memory, namely a syllable, there is a tendency for that pronunciation to be adopted. This interpretation rests on the assumption that neither the BOB nor the first vowel have any status in the syllabified representation of a word in working memory. If this post-access explanation is correct, it would mean that the nonword priming task in French was not providing any information about the possible orthographic units involved in the recognition of a French word.

There is no direct basis for supporting this post-access explanation over the explanation that the orthographic equivalents of phonological syllables form sublexical units of representation. However, it does circumvent one potential problem that exists with the latter account. If the orthographic sublexical unit is phonologically based, difficulties will arise in proposing that morphemes also form sublexical units.

There are a number of studies in French which suggest that polymorphemic words are recognized via the activation of a sublexical unit representing their stem (e.g., Beauvillain, 1994; Colé, Beauvillain, & Segui, 1989; Grainger, Colé, & Segui, 1991; Holmes & O'Regan, 1992) so that, for example, *sauter, sautais,* and *saute* all activate the stem unit *saute.* Now, while *saute* would be represented in the same way if syllables also form orthographic units (being monosyllabic), *sauter* and *sautais* would have a representation for their first syllable, *sau* (as well as, presumably, for their second syllable *ter* and *tais* respectively). The representation for *sauter* and *sautais* in terms of their morphemes is therefore incompatible with the representation in terms of their syllables. This is not a problem if the different types of sublexical unit are seen as being independent, but it is a problem for models which envisage the different levels of sublexical unit as forming a multilevel hierarchy of activation. For example, in the interactive-activation model put forward by Taft (1991, 1992, 1994), activation passes up through submorphemic units to morpheme units and then to units representing the whole word. If the submorphemic units represent syllables (rather than onsets and bodies), many of these units, for example, *sau* and *tais,* would not feed activation up to the appropriate morpheme unit, *saute,* since the latter does not include these syllables. It may be possible to argue that the unit *sau* provides some activation to the morpheme unit *saute,* but this would be no more so than it would to the morpheme units *sauve* or *sauce.*

There are several solutions to this problem. First, the hierarchical model may be an inappropriate way to conceptualize the system. Second, the finding of a PS biasing effect on the naming of nonwords may not hold up when the word prime is polymorphemic: It may be that polymorphemic words are not processed in terms of their syllables. And third, the post-access phonological matching explanation for the PS biasing effect in French may be correct, and therefore, syllables may not form orthographic units in the lexical processing system.

No resolution of the above can be given on the basis of the experiments reported here. However, whatever it turns out to be, it is apparent that English readers process printed English in quite a different manner to French readers processing printed French: Taft (1992) observed a bias in nonword pronunciations in English only when the nonword and the prime word shared a BOB, whereas the bias observed here in French occurred only when the nonword and the prime word shared a first syllable.

It should be said, however, that although the paradigms used in English and French both involved the biasing of nonword pronunciations, the type of bias was different between the two. In English, the bias was in the stress pattern assigned to the nonword; in French, it was in the pronunciation of the vowel. Is there reason to suspect that the different pattern of results could have arisen merely from this difference? It is very hard to see how. There is no obvious reason for supposing that a BOB is more compatible with syllable stress assignment than is a PS, and that a PS is more compatible with vowel assignment than is a BOB. If anything, the PS would seem to be more compatible with syllable stress assignment because it divides the word into its appropriate phonological syllable structure (e.g., *LA/ment*) whereas the BOB actually straddles the syllable boundary (e.g. *lA/Ment*). Moreover, it cannot merely be the priming of a letter in the second syllable that leads to greater second syllable stress, because Taft further showed that priming with that letter alone produced no bias at all (e.g., *domain camulk* vs *divert camulk*).

When it comes to the assignment of pronunciation to the vowel of a nonword, there is no basis for saying that the PS of the prime gives any greater guide than the BOB since the PS and the BOB both incorporate the vowel. It therefore seems very unlikely that the nature of the biasing task can explain the difference between the French and English results. Ideally, of course, one would like to compare French and English performance on identical tasks, but at this stage we have been unable to find a task which is compatible with the lexical characteristics of both French and English.

It was suggested earlier that the phonological syllable might be more relevant to French readers than to English readers because the phonological syllable structure of French is far more predictable and regular than is that of English. However, there is another possibility that can be raised, this time in regard to the predictability of the pronunciation of the vowel. In English, a vowel grapheme can often have several different pronunciations (e.g., the *a* of *fact*, *fall*, and British *fast*). It has been shown (e.g., Stanback, 1992; Treiman, Mullennix, & Bijeljac-Babic, 1993) that the consonant that follows the vowel helps to specify the vowel's pronunciation more than does the consonant preceding it. For example, the pronunciation of *a* in the VC combination *-all* is more predictable than the pronunciation of *a* in the CV combination *fa*. In French, on the other hand, spelling-to-sound correspondences for vowels are more predictable and regular, and when variations in pronunciation occur they appear to be unsystematic and not conditioned by the surrounding consonants (e.g., the *oi* pronounced /o/ in *oignon* and /wa/ in *poignée*).

The conclusion that French is processed by native speakers in a way that is qualitatively different from English was one that was also drawn by Mehler et al. (1981) and Cutler et al. (1986) in relation to spoken word processing. Interestingly, Cutler et al. (1986) further demonstrated that English speakers showed their English response pattern with French words, while French speakers showed their French pattern of responses with English words. In relation to visual word processing, it would similarly be interesting to examine whether English readers process French in the English fashion and vice versa for French readers. Unfortunately, it is probably fruitless to test this with the paradigms employed here and by Taft (1992), because English readers are unlikely to know that a capital E in French can be either *é* or *e*, whereas French readers are likely always to place stress on the second syllable of English nonwords.

In conclusion, the experiments reported here provide an interesting contrast to those reported by Taft (1992). It seems that French readers are more sensitive to the phonological syllable structure when reading French than are English readers when reading English. On the other hand, English readers appear to be more sensitive to intra-syllabic structures in the form of bodies.

The second author is Senior Research Associate of the Belgian Fund for Scientific Research. This work was supported by the Ministry of Education of the Belgian French-Speaking Community (Concerted research action, "Language processing in different modalities: Comparative approaches"). Correspondence should be addressed to Marcus Taft, School of Psychology, University of New South Wales, Sydney, N.S.W., 2052 Australia (e-mail: M.Taft@unsw.edu.au).

References

Anderson, J., & Jones, C. (1974). Three theses concerning phonological representations. *Journal of Linguistics, 10*, 1-26.

Beauvillain, C. (1994). Morphological structure in visual word recognition: Evidence from prefixed and suffixed words. *Language and Cognitive Processes, 9*, 317-339.

Bowey, J.A. (1990). Orthographic onsets and rimes as functional reading units. *Memory & Cognition, 18*, 419-427.

Cole, P., Beauvillain, C., & Segui, J. (1989). On the representation and processing of prefixed and suffixed derived words: A differential frequency effect. *Journal*

of *Memory and Language, 28*, 1-13.
Content, A., & Radeau, M. (1988). Données statistiques sur la structure orthographique du Français. *Cahiers de Psychologie Cognitive*, septembre 1988, numéro special.
Content, A., Mousty, P., & Radeau, M. (1990). BRULEX. Une base de données lexicales informatisée pour le Francais écrit et parlé. *L'Année Psychologique, 90*, 551-566.
Cutler, A., Mehler, J., Norris, D.G., & Segui, J. (1986). The syllable's differing role in the segmentation of French and English. *Journal of Memory & Language, 25*, 385-400.
Fudge, E.C. (1987). Branching structure within the syllable. *Journal of Linguistics, 23*, 359-377.
Grainger, J., Colé, P., & Segui, J. (1991). Masked morphological priming in visual word recognition. *Journal of Memory & Language, 30*, 370-384.
Holmes, V.M., & O'Regan, J.K. (1992). Reading derivationally affixed French words. *Language and Cognitive Processes, 7*, 163-192.
Kahn, D. (1976). *Syllable-based generalizations in English phonology*. Unpublished Ph.D. thesis, Massachusetts Institute of Technology.
Kay, J., & Bishop, D. (1987). Anatomical differences between nose, palm, and foot, or, the body in question: Further dissection of the processes of sublexical spelling-sound translation. In M. Coltheart (Ed.), *Attention & Performance XII* (pp. 449-469). London: Lawrence Erlbaum Associates.
Mehler, J., Dommergues, J.Y., Frauenfelder, U., & Segui, J. (1981). The syllable's role in speech segmentation. *Journal of Verbal Learning and Verbal Behavior, 20*, 298-305.
Pulgram, E. (1970). *Syllable, word, nexus, cursus*. The Hague: Mouton.
Stanback, M.L. (1992). Syllable and rime patterns for teaching reading: Analysis of a frequency-based vocabulary of 17,602 words. *Annals of Dyslexia, 42*, 196-221.
Taft, M. (1979). Lexical access via an orthographic code: The Basic Orthographic Syllabic Structure (BOSS). *Journal of Verbal Learning and Verbal Behavior, 18*, 21-39.
Taft, M. (1986). Lexical access codes in visual and auditory word recognition. *Language & Cognitive Processes, 1*, 49-60.
Taft, M. (1987). Morphographic processing. The BOSS re-emerges. In M. Coltheart (Ed.), *Attention & Performance XII* (pp. 265-279). London: Lawrence Erlbaum Associates.
Taft, M. (1991). *Reading and the mental lexicon*. Hove, U.K.: Lawrence Erlbaum Associates.
Taft, M. (1992). The body of the BOSS: Subsyllabic units in the lexical processing of polysyllabic words. *Journal of Experimental Psychology: Human Perception and Performance, 18*, 1004-1014.
Taft, M. (1994). Interactive-activation as a framework for understanding morphological processing. *Language and Cognitive Processes, 9*, 271-294.

Taft, M., & Forster, K.I. (1976). Lexical storage and retrieval of polymorphemic and polysyllabic words. *Journal of Verbal Learning and Verbal Behavior, 15*, 607-620.

Taft, M., & Zhu, X. (1994). The representation of bound morphemes in the lexicon: A Chinese study. In L. Feldman (Ed.), *Morphological aspects of language processing* (pp. 293-316). Hillsdale, NJ: Lawrence Erlbaum Associates.

Taraban, R., & McClelland, J.L. (1987). Conspiracy effects in word pronunciation. *Journal of Memory and Language, 26*, 608-631.

Treiman, R., & Chafetz, J. (1987). Are there onset- and rime-like units in printed words? In M. Coltheart (Ed.), *Attention & Performance XII* (pp. 281-298). London: Lawrence Erlbaum Associates.

Treiman, R., Goswami, U., & Bruck, M. (1990). Not all nonwords are alike: Implications for reading development and theory. *Memory & Cognition, 18*, 559-567.

Treiman, R., Mullennix, J., & Bijeljac-Babic, R. (1993). *Spelling-sound relations in English and their effects on reading*. Paper presented at the 34th annual meeting of the Psychonomic Society, Washington D.C., November 2-7.

Treiman, R., & Zukowski, A. (1988). Units in reading and spelling. *Journal of Memory and Language, 27*, 466-477.

Trésor de la Langue Française. Dictionnaire des fréquences (1971). Paris: Klinksieck.

Date of acceptance: December 31, 1994

Appendix
The items used in the three experiments

First Vowel of Priming Word is e

Nonword	PS	BOB	vowel Exp. 2	Exp.3	control
VENA	velu	menu	demi	demi	moto
PEMCR	peler	semis	melon	tenue	butin
MENAR	melon	genou	peler	jeton	coron
GENIF	gelée	venue	peser	bedon	bijou
PETAC	peser	jeton	selon	mener	fagot
PENOS	petit	mener	gelée	semis	fusil
SENOU	selon	tenue	petit	lever	mutin
SELOR	semeur	pelade	besace	menace	mouton
BEURE	besace	pelure	pesant	serein	mandat
CELUND	cerise	pelage	mesure	demain	joujou
PENOUR	pesant	menace	cerise	devoir	cousin
MERALT	mesure	serein	semeur	pelage	bandit
SELOURE	semence	belette	fenouil	vedette	vacame
BEDICTE	belotte	vedette	femelle	menotte	pirogue
BENUSSE	bedaine	menotte	semonce	velours	bouquin
BELULTE	besogne	pelisse	semence	semaine	magique
FEMICHE	fenouil	semaine	bedaine	belette	colombe
FELARRE	femelle	peluche	besogne	semoule	bouchon
SELITTE	semonce	velours	fenêtre	demande	battant
FEMASSE	fenêtre	semoule	belotte	pelisse	coutume
SERALTRE	secousse	meringue	demeures	demeures	babouche

First Vowel of Priming Word is é

Nonword	PS	BOB	Vowel Exp. 2	Exp. 3	Control
BELU	bêta	vélo	zéro	zéro	kaki
MENCU	métis	sénat	sébum	félin	wagon
MERIN	mégot	sérum	génie	sénat	fichu
GELAU	génie	félin	métis	sérum	rubis
SEMAR	sébum	fémur	pépin	béton	filou
PENUR	pépin	ténor	bémol	désir	bovin
PETUL	pénal	béton	mégot	fémur	ragot
BESUP	bémol	désir	pénal	ténor	galop
BEDOST	béguin	pédale	vérole	sénile	roulis
PENARC	pécule	sénile	béguin	fétide	mutant

Appendix (continued)

Nonword	PS	BOB	vowel Exp. 2	Exp.3	control
SECORE	séjour	bécane	pédant	pédale	pigeon
PETOUF	pédant	fétide	débile	sémite	saumon
DEMASE	débile	sémite	séjour	bécane	faucon
REVUST	rétine	sévère	désert	gélule	ballon
VELINE	vérole	gélule	méduse	sévère	donjon
RETAST	régime	tétine	césure	féroce	bonbon
MERANE	méduse	féroce	régime	tétine	salaud
CERANC	césure	mérite	pécule	ménage	bambou
DENCOUX	désert	ménage	rétine	mérite	combat
SECOUNE	sévices	bécasse	fétiche	génisse	tonnage
FENAUVE	fétiche	génisse	sévices	bécasse	lavande

Sommaire

L'importance de la syllabe dans le traitement des mots écrits en français

Les résultats d'une série d'expériences menées par Taft (1992) ont montré que le "Corps du BOSS"(BOB) serait une unité importante dans la reconnaissance visuelle de mots anglais pluri-syllabiques. "BOSS" fait référence à la première syllabe d'un mot définie orthographiquement (ex., le *lam* de *lament),* tandis que "Corps" (de l'anglais "Body") fait référence à la partie de la syllabe qui suit la (les) consonne(s) initiale(s) (ex. le *am* de *lam).* L'évidence essentielle en faveur de cette notion est que la prononciation d'un nonmot était biaisée par celle d'un mot précédent lorsque celui-ci avait le même BOB mais pas lorsqu'il avait la même syllabe initiale définie en termes phonologiques. Ainsi, le nonmot *camulk* était plus souvent accentué en seconde syllabe lorsqu'il était précédé par *lament* que par *cavort,* mots qui ont tous deux l'accent tonique sur la seconde syllabe mais dont le premier partage le BOB *am* avec le nonmot et le second, la syllabe *ca.* Cependant, on peut se demander si la notion de BOB est un concept universel, applicable à toutes les écritures alphabétiques. La plupart des langues ont une structure syllabique phonologique plus claire que l'anglais. Il se pourrait donc que, dans d'autres langues, la syllabe phonologique domine comme unité de représentation orthographique.

Les expériences rapportées ici ont été menées en français, langue dont la structure syllabique phonologique est très régulière. Le paradigme rapporté ci-dessus ne pouvait évidemment être utilisé en français puisque l'accent tonique y est toujours sur la dernière syllabe. Afin de construire des nonmots à prononciation ambiguë, nous avons utilisé des lettres majuscules et une première syllabe contenant toujours la voyelle E. Dans des items à structure initiale CVCV dont la première syllabe est CV, la lettre majuscule E utilisée comme voyelle de cette syllabe peut être prononcé *é ou e.* Dans une première expérience, chaque nonmot (ex. *MERANE)* était précédé par la version majuscule d'un mot partageant avec lui le BOB (ex. *féroce) ou* la première syllabe (ex. *méduse), ou* par la version majuscule d'un mot contrôle non relié (ex. *salaud).* Il est apparu que la prononciation du E des nonmots était biaisée par la syllabe. Le BOB induisait un biais plus faible qui n'était pas tout à fait fiable sur le plan statistique. Afin d'examiner si cet effet marginal du BOB n'était pas dû à la voyelle seule, une seconde expérience a été menée dans laquelle la condition BOB a été comparée à une condition Voyelle où le nonmot était précédé d'un mot partageant avec lui la première voyelle *(régime).* Cette expérience n'a plus donné lieu à aucun effet du BOB, et n'a pas non plus mis d'effet de la voyelle en

évidence. Une troisième expérience dans laquelle les conditions syllabe et voyelle ont été comparées a confirmé le biais induit par la syllabe ainsi que l'absence d'effet significatif de la voyelle. L'importance de la syllabe dans le traitement des mots français présentés visuellement contraste donc avec les résultats obtenus pour l'anglais où le BOB, et non la syllabe, semble être l'unité fonctionnelle.