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Lexical Access via an Orthographic Code: The Basic Orthographic Syllabic Structure (BOSS)

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Five experiments are described which detail both the structure of lexical representations accessed in visual word recognition and the method of parsing words in order to access these representations. All experiments employ the lexical decision task. The first three experiments provide support for the view that the lexical representation of a word is a representation termed here the Basic Orthographic Syllabic Structure (or BOSS) of that word rather than any articulatorily defined structure. The principle for determining the BOSS is based on both orthographic and morphological factors. Experiments 1 and 2 demonstrate that words are disrupted more when a division is made in the word according to its pronunciation than when it is made according to its BOSS. It is shown in Experiment 3 that final silent E's are not a part of the lexical representations of words and this is predicted by the BOSS principle. The last two experiments provide evidence for a parsing procedure for retrieval that is a reiterative left-to-right technique whereby lexical searches are made for combinations of letters that begin with the initial letter of the word. The results, in all, support a system of lexical access that is not mediated by phonological encoding.

In order to recognize and comprehend a written word, the orthographic representation of that word must be encoded in some way and matched with a memory, or lexical representation, in the reader's long-term word store, the lexicon. The type of encoding that is undertaken by the reader has been the subject of considerable interest in recent years. Several types of encoding have been suggested (not necessarily mutually exclusive):

(1) *Phonological encoding.* The claim has been made (e.g., Rubenstein, Lewis, & Rubenstein, 1971; Meyer, Schvaneveldt, & Ruddy, 1974) that the orthographic representation of a word is converted by grapheme-phoneme correspondence rules into a phonological representation, since it is supposed that all lexical representations of words are stored in a phonological form (though they may be stored in an orthographic form as well).

(2) *Morphological encoding.* It has been proposed (e.g., Gibson & Guinet, 1971; Murrell & Morton, 1974; Taft & Forster, 1975) that polymorphemic words are stripped of their prefixes and inflections in the recognition process since such words are stored in the lexicon in a morphologically decomposed state. For example, the lexical representation of REHEATING would be HEAT, with information about RE and ING being stored within this lexical entry.

(3) *Syllabic encoding.* Hansen and Rodgers (1968) and Spoehr and Smith (1973) have suggested that words are parsed into syllables (or, at least, syllable-like units) since it is supposed that polysyllabic words have their syllable structure represented in the lexicon. Taft and Forster (1976) also propose that

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words are analyzed into their syllables, but claim that it is only the first syllable that enters into the lexical accessing process and that the lexical representation of a word is a representation of its first syllable (after any prefixes had been stripped off), with information about the rest of the word being stored within the lexical entry.

There is, however, a major incompatibility between the method of syllabic analysis proposed by Spoehr and Smith and the experimental results of Taft and Forster. The system put forward by Spoehr and Smith involves a parsing procedure that takes into account the pronunciation of the word. For example, the correct parsing of LANTERN will be LAN TERN, the correct parsing of RIVAL will be RI VAL, and the correct parsing of RIVER will be RIV ER. The desired outcome of a parse is a division of the word into its syllables defined according to the way it is articulated (e.g., Liberman, Ingram, Lisker, Delattre, & Cooper, 1959). If it is true that words are stored in terms of their first syllables then, according to Spoehr and Smith, the lexical entry for a word like ACTOR would be completely different to that of its base word ACT, since the first syllable of ACTOR would be AC not ACT. Similarly, TABLE and TABULAR would be accessed through different entries, namely TA and TAB respectively.

There are three possible solutions to this problem.

(1) Morphologically related words may not be accessed through the same entry.
(2) The parsing rules used for polymorphemic words are different to those used for polysyllabic (monomorphemic) words.
(3) The syllables that are psychologically real in visual word recognition may not be phonetic or articulatory.

The first suggested solution is weakened by the experimental results of Gibson and Guinet (1971), Murrell and Morton (1974), and Taft and Forster (1975). These studies all support the view that polymorphemic words (at least, prefixed and inflected words) are recognized after they have been decomposed into their individual morphemes and that the accessing procedure is undertaken using a representation of the stem of the word. Thus, HEAT, REHEAT, HEATER, HEATING, HEATS, HEATED, and so on, would be accessed through the same entry (namely HEAT). As an example of one of these studies, Taft and Forster demonstrated that prefixed nonwords whose "stems" were the stems of real words (e.g., BESIST) took longer to classify as nonwords than prefixed nonwords whose "stems" were parts of, but not stems of, real words (e.g., BESCUE). This finding indicates that in the recognition of prefixed items, the prefix is stripped off and a search is made for the stem, and further, that stems of words are represented in the lexicon, even when they are not words themselves (e.g., the SIST of RESIST).

The second suggested solution is not in accord with the experiments of Taft and Forster (1976) which conclude that compound words (e.g., BOYSCOUT) are accessed in the same way as polysyllabic (monomorphemic) words (e.g., BOYCOTT), namely, through their first syllable (BOY). In addition, Taft (Note 1) reports several experiments that suggest that derived words (e.g., GUSTY, BASIC) are also accessed through their first syllable, in the same way as polysyllabic (monomorphemic) words (e.g., GUSTO, BASIN). For example, it was demonstrated that nonwords which were the stems of derived words, as well as being their first syllable (e.g., DIZZ from DIZZY, GROCE from GROCER) led to just as much interference in their classification times as did nonwords which were the first syllables of polysyllabic nonderived words (e.g., FUMB from FUMBLE, TRINK from TRINKET). This result implied that words are represented in the lexicon in terms of their first syllable (which in the case of derived words also happens to be their stem) since first syllables took longer to classify as nonwords than nonwords which were not first syllables.

For the above reasons, the third suggestion, that syllables arising from articulation are simply not involved in visual word recognition, seems the most preferable. How might this arise? Let us first consider *storage*. When a person encounters a new word that is to be stored in his lexicon, he must decide what the first syllable of that word is. But if the syllable that is stored is not phonetic, what is it? Either it must be based on orthographic principles (or perhaps systematic phonemic principles, which are very similar to orthographic principles) or on morphological principles. Examples of the latter are cases like CHEAPLY and TEAPOT where the syllabification must be CHEAP LY and TEA POT if the relationship between CHEAPLY and CHEAP, and TEAPOT and TEA, is to be maintained. What happens, though, when there is no morphological motivation for syllabification? In these cases, orthographic principles must be invoked. The word WALRUS, for example, must be syllabified as WAL RUS since the letter combination LR is an orthographic combination that occurs neither initially nor finally in English (i.e., it violates what I will term *orthotactic* rules). Of course, WALRUS would be syllabified as WAL RUS on phonological grounds also, since the combination /lr/ violates phonotactic rules (i.e., rules of phonemic sequential co-occurrence). There are cases, however, where orthotactic rules are violated, but phonotactic rules are not.

Take, for example, the word GENTLE. On orthographic grounds this word must be syllabified as GENT LE since the combination TL violates orthotactic laws. When pronounced, however, the ending of GENTLE is not /tl/but/tɔl/, and thus phonotactic laws are not violated. Accordingly, the syllabification of GENTLE based on its pronunciation is GEN TLE (according to the rules of Hansen and Rodgers and Spoehr and Smith, as well as *Webster's Third New International Dictionary*). But consider the word GENTLY. Syllabification based upon orthographic principles still yields the first syllable GENT. Syllabification based upon pronunciation, however, runs into a major problem, since the syllabification GEN TLY leads to a phonotactic violation in English, namely an initial /tl/. The syllable-like unit proposed by Spoehr and Smith is defined by these authors as being the smallest pronunciational unit within which all phonotactic rules can be specified. Does this mean that /tl/ should not be considered a phonotactic violation, despite the fact that it never appears initially in a word in the English language? Or does it mean that GENTLE should be syllabified as GENT LY while GENTLE is syllabified as GEN TLE, thus losing the relationship between the two words? It appears that syllabification guided by orthotactic principles is the best solution, so that GENTLE will be syllabified as GENT LE, and ANKLE as ANK LE because the combinations TL and KL do not occur either word initially or word finally.

Now consider the word UNCLE. The combination CL cannot occur in final position, but it can occur in initial position. Thus there are no orthotactic principles preventing the syllabification UN CLE. However, if ANKLE is to be syllabified as ANK LE it would seem unparsimonious not to syllabify UNCLE as UNC LE (or TEMPLE as TEMP LE, FABLE as FAB LE, etc.). One can capture this generality by stating the syllabification principle in the following way: include in the first syllable all consonants following the first vowel group that do not violate any orthotactic rules. Thus UNCLE will be syllabified as UNC LE since NC does not violate orthotactic rules (e.g., ZINC), but NCL does. Similarly, FABLE will be syllabified as FAB LE since B is a valid final consonant (e.g., RIB), but BL is not. When a word possesses no letter combinations that violate orthotactic laws (e.g., MASTER), the principle stated above will give the syllabification MAST ER (not MAS TER nor

MA STER, even though both are orthotactically valid).

Clearly, even though the orthographic principle given works in most cases, it alone cannot account for all syllabifications; morphological factors must sometimes override them. For example, on the basis of the orthographic principle stated above, the first syllable of TEAPOT would be TEAP while the first syllable of NEARLY would be NEARL and thus the relationship between TEAPOT and TEA, and NEARLY and NEAR, would be lost. So the principle for assigning orthographic syllabification to a word for storage purposes must be restated as follows: *include in the first syllable as many consonants following the first vowel of the word as orthotactic factors will allow without disrupting the morphological structure of that word.* I will term this orthographically/morphologically based syllable the "Basic Orthographic Syllabic Structure" or "BOSS."

The first three experiments to be reported are attempts to provide evidence for the above-stated BOSS principle. This orthographic/morphological syllable (i.e., the BOSS) is contrasted to the pronunciation based syllable as set out by Hansen and Rodgers, and Spoehr and Smith.

Experiment 1

In order to test the proposal that polysyllabic words are stored with a syllabic analysis based upon their orthography and not upon their pronunciation, a variation on the lexical decision task (see Rubenstein, Garfield, & Millikan, 1970) was employed. Subjects were presented with a series of words and nonwords (e.g., LANTERN, BLUNDIN) and their task was to classify each item as a word or a nonword as quickly, but as accurately as they were able. Every item, however, was split up into two units (e.g., LANT ERN, BLUN DIN). Subjects were instructed to ignore the gap that appeared within the item. There were two positions in which the gap could appear. Either the word was divided after its first articulated syllable as defined by Spoehr and Smith (e.g., LAN TERN, SPI DER) or it was divided after its BOSS (e.g., LANT ERN, SPID ER). The aim of having a gap was to attempt to guide the analysis imposed by subjects in the retrieval process. If the division of the stimulus item did not coincide with the structure stored in the lexicon for that item, then, it was hoped, the speed of the lexical decision response would be slower than when the division of the stimulus item did coincide with the stored structure.

According to the pronunciation theory of syllabic analysis (Spoehr & Smith, 1973) the lexical entry for LANTERN would be represented with the analysis LAN TERN. Thus stimulus words which are divided up according to their pronunciation (P-Group Condition) should be more quickly recognized than words which are not. On the other hand, the orthographic theory of syllabic analysis (as given by the BOSS principle) would say that the lexical entry for LANTERN would be LANT and not LAN. Thus stimulus words which are divided up according to their orthography (O-Group condition) should be more quickly recognized than words which are not.

Method

Materials. The experiment used sixteen words which either had a long first vowel (e.g., SPIDER) or a medial consonant cluster (e.g., LANTERN). These words were designed in pairs matched on frequency, length, and on whether they had a medial consonant cluster or not (for example, LANTERN was matched with HARVEST). There were thus eight such pairs. Half of the subjects were presented with the first member of each pair as a P-Group item and the second member as an O-Group item, while the other half saw the first member as an O-Group item and the second as a P-Group item. A P-Group item was one where the word was divided up after the first vowel if this first vowel was long (SPI DER) or after the first medial consonant if there was a medial consonant cluster (LAN TERN). That is, the items were divided up according to the parsing principle put forward by Spoehr and Smith (1973). An O-Group item was one where the word was divided up according to the BOSS principle, regardless of pronunciation (SPID ER, LANT ERN). By setting up the items in this way, not only was an item analysis possible, comparing LAN TERN directly to LANT ERN, but also a subject analysis could be performed comparing the P-Group condition items to the O-Group condition items with frequency, length, and word structure equated across conditions for each subject.

The 16 word items seen by each subject were randomly presented together with 35 nonword items as well as 20 word items which will be described in the discussion of this experiment. All items were split up in some way. Ten practice items were given.

Procedure. Items were typed on cards in lower case and presented on a two field tachistoscope for an exposure period of 500 msec. Subjects responded by saying "yes" into a microphone when they recognized the item as a word and "no" when they recognized it as a nonword. Subjects were instructed to ignore the gap within each item and to respond as quickly but as accurately as they were able. The timing mechanism was triggered by the onset of the stimulus presentation and stopped by the onset of the vocal response. The intertrial interval was approximately 5 sec, with the experimenter saying "ready" prior to the presentation of each stimulus item. The items were presented in a different order for each subject.

Thirty students at MIT were used as subjects. Fifteen subjects saw a set of items where half of the words were P-Group items and half were O-Group items. The other 15 subjects saw a second set where the items that were in the P-Group condition in the first set were now in the O-Group condition, and the items that were in the O-Group condition were now in the P-Group condition.

TABLE 1

Mean Reaction Times (msec) and Standard Errors along with Percentage Error Rate for the P-Group Items and the O-Group Items

Condition	Example	RT	SE	%E
P-Group	LAN TERN	618	10	3
O-Group	LANT ERN	579	11	3

Results and Discussion

Table 1 presents the mean reaction times across items for the two conditions.

An analysis of these means revealed that O-Group items were more quickly recognized than P-Group items [$minF'$ (1,43) $= 7.96, p < .01$]. This result indicates that the division of a visually presented word into its orthographically defined syllables is less disruptive to recognition than the division of a visually presented word into its articulation-defined syllables. It may be, of course, that the division of a word into its orthographic syllables is not disruptive at all or that it is even facilitative. However, no evidence is presented here to allow an evaluation of such claims. Experiment 2 considers this question. What is important though, is that orthographic syllables appear to form the basis of the access code for visual word recognition, rather than articulation-defined syllables.

One criticism that could be made of this experiment is that O-Group condition items were more quickly recognized than P-Group

items because there were more letters provided before the gap. Thus LANT conveys more information about LANTERN than does LAN. In order to counter this criticism, it must be shown that O-Group words are more quickly recognized than words divided up at a point *after* their BOSS. For example, the BOSS of BOYCOTT would be BOY (since YC is an orthotactic violation) and thus BOY COTT should be quicker to recognize than BOYC OTT despite the fact that BOYC has more letters than BOY. Morphological principles also provide items of interest. For example, the BOSS of FULFILL would be FUL on morphological grounds, and thus FUL FILL should be more rapidly recognized than FULF ILL.

Twenty such items were included in Experiment 2 to insure that the effect obtained was not a result of the length of the first word chunk. It was found that the mean reaction time to the words broken up according to their BOSS (BOY COTT) was shorter than that to words broken up at a point after their BOSS (BOYC OTT): 614 vs 656 msec. This difference was significant on both the subject and item analyses but not on *minF'* [$minF'$ $(1,48)=3.77$, $p>.05$]. However, the failure to reach significance is not crucial for the argument against the notion that the advantage of LANT ERN over LAN TERN was a result of there simply being more letters in LANT than LAN. Had the number of letters in the first chunk been the essential factor, then items like BOYC OTT should have been *more* quickly responded to than items like BOY COTT. But, if anything, the reverse was true.

Since the results of this experiment have such important implications for theories of lexical storage, and further, since the finding is hardly an intuitively obvious one, it was considered advisable to try to replicate the O-Group/P-Group difference with a different set of items and subjects. In this second experiment, however, rather than separating the units of a word by means of a gap, the boundary between units was marked by a case transition. A word either shifted from upper case to lower case (e.g., MUSTard) or from lower case to upper case (e.g., zeRO). It would be unconvincing if the effect observed in the first experiment was dependent upon the word being divided by a gap and not by any other means. If, on the other hand, the O/P difference was still observed using the case alternation method of division then the conclusions drawn from Experiment 1 would be strengthened.

In addition to altering the method of word division in the second experiment, an attempt was made to improve upon the method of item selection. Items were chosen for Experiment 1 purely on the basis of whether they possessed a medial consonant cluster or a long first vowel. Other than this, there were no systematic criteria for deciding which words would be included and which would not. The second experiment, on the other hand, employed a totally automatic and thus objective method of item selection. Highly rigorous criteria were adopted for item selection and all words meeting these criteria were used in the experiment.

Experiment 2

Experiment 2 differed from Experiment 1 in five ways:

(1) Word items were selected systematically.
(2) Rather than splitting up each item into units by means of a gap, the units were demarcated by a transition from upper case to lower case or from lower case to upper case (e.g., MUStard vs MUSTard, zeRO vs zerO).
(3) A third condition was included where the item was left intact, either completely in upper case or completely in lower case.
(4) Nonword items were constructed so that they could be analyzed in the same way as word items.

(5) Stimulus display was controlled by a PDP 11/10 computer.

The changes outlined in Points 1, 2 and 5 were methodological changes that should not have altered the basic findings. If O-Group words were still found to be recognized faster than P-Group words in Experiment 2 then the generalizability of the effect would be well established.

The predictions made for nonwords (Point 4) is that O-Group items and P-Group items should not differ since there is no stored structure for nonwords and thus an exhaustive search would be undertaken in both cases trying out all possible encodings. Thus for a nonword like SILPONTH, both a SIL PONTH parse and a SILP ONTH parse must be found to be unsuccessful before it can be decided that SILPONTH is not a word.

The nondisrupted condition was included (Point 3) to examine whether the O-Group items were not only more easily recognized than P-Group items but also facilitated recognition compared to an intact normally presented item. It would be very interesting if the results did demonstrate such a facilitation since the O-Group items are physically disrupted and this may well delay the letter identification stage of processing. Words written with case alternating from letter to letter do indeed increase recognition difficulty (Coltheart & Freeman, 1974; Fisher, 1975). Of course, the present experiment involves only one shift in case type and is thus less of a disrupted stimulus than when case type alternates from letter to letter.

Method

Materials. The items that were selected were *all* those words falling in a particular frequency range (20–30 according to Kučera & Francis, 1967) that met the following criteria.

(1) The word was to be polysyllabic and 4–7 letters long.
(2) The word was to either have a medial pair of nonidentical consonants (e.g., the ST of MUSTARD) or a long first vowel (e.g., the E of ZERO).
(3) A medial consonant pair could not be NG or NK since the N could then be pronounced as /ŋ/ and not /n/. A P-Group division would not represent the correct pronunciation in this case. For example, BLANket would lead to the pronunciation /blæn kət/ and not /blæ kət/.
(4) The word was not be to polymorphemic (e.g., NERVOUS, PROTEST, RACES). Every word that met the above criteria was used in the experiment. There were 44 such words and these are presented in the Appendix.

Words were presented either as P-Group items or as O-Group items. Grouping of letters was achieved by presenting the letters of the grouping in a different case from the rest of the word (i.e., either upper or lower case). Half of the items were randomly assigned to an upper case followed by lower case set (e.g., MUSTard) while the other half were assigned to a lower case followed by upper case set (e.g., zeRO). P-Group items were words where the case transition was made at the phonetic syllable boundary as defined in Experiment 1. That is, where there was a medial consonant pair the division was made between the two consonants (e.g., MUStard) and where the first vowel was long the division was made immediately after this vowel (e.g., zeRO). Grouping of letters in the O-Group items conformed to the BOSS principle regardless of pronunciation (e.g., MUSTard, zerO).

The items were presented to two groups of subjects and were selected randomly to appear either as P-Group words for the first set of subjects while being O-Group words for the second set, or as O-Group words for the first set of subjects while being P-Group words for the second set. Thus one group of subjects would have been presented with MUSTard while the other group was presented with MUStard. Each subject saw 22 P-Group words and 22 O-Group words.

TABLE 2

MEAN REACTION TIMES (MSEC) AND STANDARD ERRORS ALONG WITH PERCENTAGE ERROR RATE FOR THE P-GROUP, O-GROUP, AND N-GROUP WORDS AND NONWORDS

Condition	Example	RT	SE	%E
Words				
P-Group	MUStard	594	6	6
O-Group	MUSTard	576	5	7
N-Group	CHAPEL	550	5	7
Nonwords				
P-Group	SILponth	645	6	9
O-Group	SILPonth	639	6	8
N-Group	VOLPENCH	639	6	8

In addition to the P-Group and O-Group words, each subject was presented with a set of 22 words whose case was maintained throughout the whole item (N-Group words). Half of these were presented totally in upper case (e.g., BLANKET) and half were presented totally in lower case (e.g., merit). The N-Group words were polysyllabic words selected from the frequency range 20–30, but otherwise did not comply with the criteria for the selection of the O-Group and P-Group words (since all such items were already assigned to these conditions).

Fifty-four nonwords were designed to be similar in structure to the words. All nonwords had either a nonidentical medial consonant pair (e.g., SILPonth, GRONDIN) or a long first vowel (e.g., loBEN, hureal). Half the subjects saw 18 of the nonwords as P-Group items (e.g., SILponth) and 18 as O-Group items (e.g., lobEN), while the other half saw the reverse (e.g., loBEN and SILPonth). The other 18 items were N-Group nonwords, half of which were totally in upper case (e.g., GRONDIN) and half totally in lower case (e.g., hureal). Items are listed in the Appendix.

Procedure. The 120 experimental items were presented randomly to 30 subjects (15 subjects for each of the two lists of items), along with 12 practice items. Students from Monash University served as subjects. The procedure followed was the same as for Experiment 1 except that, rather than presenting the stimuli on a tachistoscope, a PDP 11/10 computer was used to control the stimulus display via a video display unit. Subjects were self-paced, pressing a foot switch each time they wished to receive the next item.

The subjects were instructed before the experiment that many of the items would be in mixed case, but that they were simply to decide whether the items were words or not.

Results and Discussion

Table 2 provides the mean reaction times across items for the word conditions and the nonword conditions.

Looking first at the word items, it was found that the effect observed in Experiment 1 was replicated. P-Group items were found to take significantly longer to recognize than O-Group items [$minF'$ (1,72) = 4.04, $p < .05$]. This result, then, supports the claim that words are stored on an orthographic basis (namely, according to the BOSS principle) and not on a pronunciational basis. Dividing a word up into its pronunciational units is more disruptive than dividing it into its orthographic units.

As predicted, P-Group items did not differ from O-Group items when the items were nonwords ($minF' < 1$). In both conditions all possible parsings must be tried out, and therefore, grouping the letters of a nonword item into one or the other parsing should not effect reaction times.

The one puzzling result was obtained with the N-Group items. For words, N-Group items were faster than both O-Group items [$minF'$ (1,87) = 6.76, $p < .02$] and P-Group items [$minF'$ (1,90) = 17.26, $p < .001$]. However, for nonwords, response times did not differ between any of the conditions ($minF' < 1$ in each case). The difference observed for the word items could be explained simply at the letter identification stage of processing where reaction times may be lengthened by having to switch case in mid-stream. However, if the effect lay simply at the letter identification stage the same effect should have been observed with nonwords, yet it was not. One possible explanation for this could be that nonword decisions are made according to a time criterion measured by the subject from the time the stimulus is presented. If no appropriate lexical entry is located within this time limit the subject decides to respond "No." This is in contrast to the view that a negative response is given only after a complete and exhaustive search has been made of the lexicon. According to the time criterion model, a nonword decision would be made in the same time regardless of whether the letter identification stage was slowed down or not, since the time limit is measured from stimulus onset. The idea of such a deadline time for negative responses is discussed by Coltheart, Davelaar, Jonasson, and Besner (1977), (though the time criterion that they propose has the added property of being able to vary depending upon the similarity of the nonword to a word).

Other explanations can be given to account for the observation that N-Group items are the easiest items to recognize only when they are words. The finding that O-Group words were faster to recognize than P-Group words was interpreted as demonstrating that an O-Group division was consistent with stored information while a P-Group division was not. Following this logic, the finding that N-Group words were faster than O-Group words could be interpreted as demonstrating that words are stored as whole entities rather than in terms of BOSSes. However, since a P-Group/O-Group difference was also obtained, what one must say according to this view, is that there is storage both of the whole word *and* of its BOSS, but that the whole word is more readily accessible. By this view, there would be no difference between the nonword conditions since all possible encodings must be attempted in every case. The problem with the above proposal, however, is that there would appear to be no reason at all for BOSS storage if whole word storage was always the more accessible. Thus it seems preferable to claim that only one or the other type of storage exists. If one were to claim that this one type of storage was of the whole word then the O/P difference could not be explained and neither could the results of Taft and Forster (1976). If, on the other hand, one were to claim that storage was only in terms of the BOSS, as this paper has indeed claimed, then the O/P difference could be accounted for. The N/O difference could be explained by the letter identification disruption proposal with a time deadline being postulated for nonword classification.

One interesting extension of the storage of words according to the BOSS principle is the effect upon storage of words ending in silent E. Since the BOSS principle stipulates that in storage the representation of a word terminates with the consonant or consonant cluster following the first vowel, any vowels occurring after these consonants cannot be a part of the BOSS. A final silent E is orthographically such a vowel and therefore should not be included in the BOSS. In other words, TASTE should be stored as TAST, WISE as WIS, and STONE as STON.

Experiment 3 attempts to evaluate the claim that words are represented in the lexicon without their final silent E. If the claim is

TABLE 3

MEAN REACTION TIMES (MSEC) AND STANDARD ERRORS ALONG WITH PERCENTAGE ERROR RATES FOR CONDITIONS 1, 2, 3, AND 4

Condition	Example	RT	SE	%E
Nonwords				
1	STON	827	16	4
2	SLON	785	11	4
Words				
3	SHIN	770	13	6
4	SWAN	741	11	5

supported, then the argument for the BOSS principle will be further strengthened.

EXPERIMENT 3

The design of this experiment follows the design of several interference experiments reported by Taft and Forster (1975, 1976). If parts of words are presented to subjects and found to have relatively slow classification times as nonwords or words, then it is concluded that these word parts are stored in the lexicon. Thus, it was concluded by Taft and Forster (1975) that INFECT is stored as FECT and PREVENT is stored as VENT, since FECT and VENT took longer to classify than control items. Similarly, it was concluded (Taft & Forster, 1976) that ATHLETE is stored as ATH and NEIGHBOR stored as NEIGH, since ATH and NEIGH took longer to classify than control items. The fact that FAW and SHREW did not take longer to classify than control items indicated that FAWN is not stored as FAW and SHREWD is not stored as SHREW.

Now, if silent E's are not present in the lexical representations of words, then items like STON (Condition 1) should take longer to classify as nonwords than items like SLON (Condition 2), since the entry for STONE (namely STON) will be encountered during the lexical accessing process. Similarly, items like SHIN (Condition 3) should take longer to classify as words than items like SWAN (Condition 4) since the lexical accessing process will encounter the entry for SHINE (being of higher frequency than SHIN) prior to the entry for SHIN.

Method

Materials. Fifteen Condition 1 nonwords were constructed by removing the final silent E from 15 monosyllabic words (e.g., STON from STONE). These items were matched for length and CVC structure with 15 Condition 2 nonwords which were not generated from words with silent E's (e.g., SLON).

The word items of Conditions 3 and 4 were equated for frequency, CVC structure, and length. There were 15 words in each condition. The words of Condition 3 were words which were of lower frequency than other words of the same form but with a final silent E (e.g., SHIN, which is of lower frequency than SHINE). Condition 4 words were not related by a final silent E to any other words (e.g., SWAN).

The 60 items were presented to subjects in different random orders following 10 practice items. The procedure was otherwise the same as that described in the first experiment.

Results and Discussion

Mean reaction times across items for the four conditions are presented in Table 3.

A comparison of the two nonword conditions revealed a significant difference [$minF'$ (1,27) = 6.83, $p < .02$], with Condition 1 (STON) taking longer to classify than Condition 2 (SLON). A similar comparison of the word conditions also yielded significance [$minF'$ (1,30) = 4.99, $p < .05$], with Condition 3 (SHIN) taking longer to classify than Condition 4 (SWAN).

The finding of an interference effect both for nonwords like STON and words like SHIN supports the view that silent final E's are not a part of the lexical representations of words. Therefore, the BOSS of STONE is STON and the BOSS of SHINE is SHIN and this is in line with the stipulation of the BOSS principle that the BOSS contains only the first vowel or vowel group orthographically defined.

It is of interest to note that the final silent E of a word is very often dropped when the word is suffixed. For example, when ING is added to STONE or when DOM is added to WISE, the final E is deleted in the orthography of the resultant word (STONING, WISDOM). Now, according to the BOSS principle, STONING would be stored as STON, WISDOM as WIS, TASTY and TASTING as TAST, and so on. Therefore, the conclusion that words are stored without their final silent Es means that STONE and STONING have the same BOSS (namely STON), WISE and WISDOM have the same BOSS (WIS), and so on. Such a state of affairs allows words related by affixation to be stored together under the one lexical representation. Thus STONING could be accessed through the same lexical entry as STONE, and WISDOM could be accessed through the same lexical entry as WISE. No experimental evidence is presented here, however, that speaks to such a claim.

One argument that may perhaps be raised against the interpretation of Experiment 3 is that Condition 1 nonwords like STON seem to *sound* more like real words than Condition 2 nonwords like SLON, and thus the result may in fact be due to pronunciation and not to the BOSS principle. That is, the pronunciation of STON (namely /ston/ is similar to the pronunciation of STONE (namely /stoʊn/), whereas /slon/ is not similar to the pronunciation of any real word. This possible explanation for the result seems unfounded, however, when one considers some of the other items used in the experiment. For many of the item pairs, the Condition 2 nonword was just as similar in pronunciation to a real word as was its matching Condition 1 nonword, and in some cases, was even *more* similar. For example, /dæŋk/ (the pronunciation of the Condition 1 item DANC) is similar to /dæns/ (the pronunciation of the word DANCE, but /rɪŋk/ (the pronunciation of the Condition 2 item RINC) is just as similar to /rɪns/ (the pronunciation of the word RINSE). Similarly, while HOM (Condition 1) has a similar pronunciation to HOME, LOM (Condition 2) has just as similar a pronunciation to LOAM or even LOOM. The pronunciation of SCEN (Condition 1) is not at all similar to the pronunciation of SCENE (i.e., /sken/ compared to /siːn/), and CRING (Condition 1) is *less* similar in pronunciation to CRINGE than BLING (Condition 2) is to BLINK (i.e.,/krɪŋ compared to /krɪnj/ versus /blɪŋ/ compared to /blɪŋk/). So it can be seen from these examples (and these are not the only ones) that it is highly unlikely that the result obtained in Experiment 3 can be accounted for by phonological similarity to words.

Experiments 1, 2, and 3 have provided evidence for the storage of words as representations of their BOSS, being that unit of the first morpheme of the word that includes as many consonants after the first vowel as is orthographically valid. So the word LANTERN would have LANT as its BOSS since this takes in all the consonants after the first vowel of the morpheme LANTERN; the word SLANT would have SLANT as its BOSS since SLANT is the first (and only) morpheme of the word and at the same time includes all the consonants after the first vowel; the word PEARLY would have PEARL as its BOSS since the first morpheme is PEARL; and the word NEARLY would

have NEAR as its BOSS since the first morpheme is NEAR.

So far, discussion of the parsing of a word into its BOSS has been solely in terms of storage. That is, when a new word is to be stored the BOSS principle is applied so that the word can be stored as a representation of its BOSS. But what about *retrieval*? How will the identification of the BOSS of a word come about during word recognition since it is not always possible to parse a word into its BOSS during on-line processing. This is because it is not always possible to identify the first morpheme of a word on a purely orthographic basis. For example, from orthography alone one cannot know whether the first morpheme of PEARLY (and, in this case, the BOSS) is PEAR or PEARL, and similarly whether the first morpheme of NEARLY is NEAR or NEARL. Therefore, in order for the correct parse to be made, simple on-line application of the BOSS principle is not possible. What is possible as an alternative, however, is some sort of reiterative parsing process whereby various parses are attempted until the correct one (that is, the one that corresponds to the stored representation) is attained. The parsing rules of Hansen and Rodgers (1968) are of this type. If the first attempted parse is found not to match with stored information then a second, different parse is attempted. Of course the parsing rules proposed by Hansen and Rodgers were designed to coincide with the pronunciation of the words and this has been demonstrated in the present experiments to be untenable. Nevertheless the same sort of reiterative parse idea could be applied to the BOSS notion. That is, the word might firstly be divided up after all the consonants following the first vowel and if this were then found to be inappropriate (e.g., in the case of NEARLY), a division would be attempted between the two medial consonants (correctly giving NEAR + LY).

A second possible reiterative parse approach was suggested by Taft and Forster (1976). The suggestion made was that words are recognized via a left-to-right reiterative parse technique in which a lexical search is undertaken for successive letter combinations beginning with the initial letter of the word (after any prefixes). Once a lexical entry is encountered, it must then be determined whether or not the letters that are represented by the lexical entry form the BOSS of the word that was presented. If it does not, then the left-to-right parse must continue. For example, the recognition of the word CANDLE would involve a search for CA (an abortive search) a search for CAN (where a lexical entry would be found but ascertained to be inappropriate) and finally CAND (the appropriate entry, where all information about CANDLE would be stored).

The evidence that was presented by Taft and Forster for this left-to-right parse technique is, in fact, not inconsistent with the first-mentioned reiterative parse technique, namely the one where the first parse is made according to the BOSS principle. The evidence that was put forward was that classification times of nonwords that were made up of two units were lengthened when the first unit formed a word, even where there was no clear orthographic boundary between the units. Thus, TRUCERIN took longer to classify as a nonword than GLICERAX to the same extent that LATCHMUN took longer to classify than BONCHMIP. There would be orthographic motivation for dividing the latter two items between the CH and the M, but none for dividing the former two between the E and the R. The fact that the clearness of boundary was not important led Taft and Forster to propose the left-to-right parse technique. However, reiterative BOSS principle application would lead to the same result. If the BOSS principle was applied in order to parse TRUCERIN (and most of the items used by Taft and Forster were of this type) then TRUC would be isolated as the first potential BOSS and this indeed would be the BOSS of the word TRUCE (from the results of Experiment 3 presented here). Thus interference effects

would be obtained as strongly for items like TRUCERIN as they would be for items like LATCHMUN (where LATCH would be isolated as the first potential BOSS) and this is what was found by Taft and Forster.

It can therefore be seen that no evidence has yet been presented that clarifies which of the two possible reiterative parse proposals, if either, is the correct one. The following experiment is an attempt to provide such evidence.

Experiment 4

There is at least one type of item where the two parse techniques make different predictions. These items are nonwords which form a single BOSS (i.e., they are monosyllabic) but begin with a word. For example, the nonword MEATH begins with the word MEAT, but its BOSS would be MEATH. If the left-to-right parse hypothesis is correct (LR hypothesis), when MEATH is presented, a search will be made for MEAT (as well as ME, MEA, and MEATH) and the consequent location of a lexical entry will lead to an interference effect of the sort observed by Taft and Forster (1976) on items like TRUCERIN and LATCHMUN. If, however, the BOSS principle is applied in the recognition process (BP hypothesis) then, since the only possible parse of MEATH is MEATH, the presence of the word MEAT at the beginning of the nonword would never produce any interference.

An equivalent set of predictions can be made about word items. If a word has another word as its beginning (e.g., BEARD beginning with BEAR) then according to the LR hypothesis, an interference effect should be observed. That is, the lexical entry for BEAR would be initially located when in fact BEARD is the lexical entry that is appropriate. The BP hypothesis, on the other hand, would never expect BEAR to interfere with BEARD since the first (and only) parse would yield the correct representation BEARD.

Experiment 4, therefore, attempts to separate the LR and BP hypotheses by comparing nonwords like MEATH to control nonwords like HOUTH and words like BEARD to control words like STORM. If the items with a word at their beginning take longer than the control items then the LR hypothesis will be supported over any other. If, on the other hand, no interference effects are observed, then the BP hypothesis would be supported more strongly than the LR hypothesis.

Method

Fifteen nonwords were constructed by adding a letter to the end of 15 common words (e.g., MEATH, FREEN). These nonwords constituted the W nonword condition. Matched with each of these nonwords was another nonword that did not begin with a word, but was of similar orthographic structure to its matching W nonword (e.g., HOUTH, SLEEM). These nonwords comprised the N nonword condition.

The 30 nonword items were presented together with 30 word items. Half of the word items were selected so that each began with a different word of higher frequency than itself (e.g., BEARD, PAINT). These words constituted the W word condition. Matched for frequency with each of these W words was an N word. These words did not begin with another word (e.g., STORM, GUEST).

The apparatus and procedure were the same as in Experiment 3. There were 15 subjects.

Results and Discussion

The mean reaction times and percent error rate for the nonword and word items are presented in Table 4.

A comparison of the nonword items revealed that classification times to W nonwords were significantly longer than those to N nonwords [$minF'(1, 28) = 6.44$, $p < .02$]. The equivalent result was obtained with W words and N words [$minF'(1, 28) = 4.43$, $p < .05$].

TABLE 4

MEAN REACTION TIMES (MSEC) AND STANDARD ERRORS ALONG WITH PERCENTAGE ERROR RATE FOR W AND N NONWORDS, AND W AND N WORDS

Condition	Example	RT	SE	%E
Nonwords				
W	MEATH	700	12	12
N	HOUTH	656	8	7
Words				
W	BEARD	611	14	8
N	STORM	570	11	8

It is clear from the results that the presence of an inappropriate word at the beginning of a nonword or word interferes with the classification response. This finding, then, suggests that retrieval of words from the lexicon is achieved via a left-to-right parse technique, namely the LR hypothesis put forward by Taft and Forster (1976). If retrieval were carried out according to the BP hypothesis (initially applying the BOSS principle to the word and then re-parsing if this were unsuccessful) then no interference should be observed for W nonwords and W words since the word appearing at the beginning of the item should never be encountered.

So, to reiterate, while it is postulated that words are *stored* as representations based upon the BOSS principle it is proposed that words are *retrieved* by a reiterative left-to-right parse technique and not by application of the BOSS principle.

EXPERIMENT 5

An essential feature of the left-to-right search model is that it begins at the extreme left of the word, that is, at the first letter of the word. It is necessary to postulate this in order to explain why the presence of a word in the last syllable position of a nonword (e.g., FLURBPAIR) does not lead to interference effects (Taft & Forster, 1976). To further demonstrate this point Experiment 5 was designed using items where a single letter was added to the beginning of a word to form a nonword (e.g., GLIVE from LIVE) or a less frequent word (e.g., CLOVE from LOVE). If it were shown that the presence of a word at the end of a nonword or less frequent word did not cause any interference to lexical decision responses, then the left-to-right search procedure would be further supported since it was shown, in Experiment 4, that one does get interference when there is a word at the very *beginning* of a nonword or less frequent word.

Method

Fifteen W nonwords were constructed by adding a letter to the beginning of 15 common words (e.g., GLIVE, TWAIT). For each of these nonwords was another nonword that did not end with a word, but was similar in consonant-vowel structure to its matching W nonword (e.g., GLITE, TWILK). These nonwords constituted the N nonword condition.

The 30 nonword items were presented along with 40 word items. Half of the word items were W words being constructed by the addition of a letter to the beginning of 20 common words (e.g., CLOVE, THIGH). Matched for frequency with each of these words was an N word. These words did not end with another word (e.g., CROAK, THUMB).

The apparatus and procedure were the same as in Experiment 3. There were 15 subjects.

TABLE 5

MEAN REACTION TIMES (MSEC) AND STANDARD ERRORS ALONG WITH PERCENTAGE ERROR RATE FOR W AND N NONWORDS, AND W AND N WORDS

Condition	Example	RT	SE	%E
Nonwords				
W	GLIVE	601	7	4
N	GLITE	606	11	6
Words				
W	CLOVE	550	12	4
N	CROAK	575	15	6

Results and Discussion

Mean reaction times and percentage error rate are presented in Table 5.

There was found to be no difference in reaction time either between W nonwords and N nonwords ($minF' < 1$) or between W words and N words [$minF'(1,33) = 2.14$, $p > .05$], (although the subject analysis was significant [$F(1,14) = 5.21$, $p < .05$], with reaction times actually being *shorter* for the W words than for the N words).

These results confirm the prediction that a word contained in a nonword or word item will only cause interference to the classification response if it is at the beginning of that item, that is, a lexical entry for the word that is included in the item will only be encountered if it is at the beginning. This finding, in conjunction with the results of Experiment 4, support the claim that the lexical representation of a word (namely, its BOSS) is retrieved via a parsing technique whereby a lexical search is made for all letter combinations within an item that begin with the first letter of that item. When there is a lexical entry that is congruent with one of these letter combinations, then this letter combination becomes a candidate for being the BOSS of the word.

GENERAL DISCUSSION

As stated in the introduction, a written word is recognized after the orthographic representation of that word is parsed in some way and then found to match with a lexical representation. The present experiments address the two issues of how the word is parsed and how the representation of the word is encoded in the lexicon. The results of the first three experiments, along with those obtained by Taft and Forster (1976), argue for the notion that words are encoded in the lexicon as representations of their first syllable defined orthographically and morphologically rather than phonetically. More precisely, the lexical representation of a word is a representation of that part of its first morpheme that includes after its first vowel all consonants that do not violate rules of orthographic co-occurrence. This is the BOSS.

The method of parsing is suggested by the last two experiments to be a reiterative left-to-right technique whereby lexical look-up is attempted for those letter groupings within a word that begin with the initial letter of that word. When a lexical representation is located by this technique the lexical entry must be examined further in order to ascertain whether or not it is the appropriate entry. For example, if the lexical entry for BEAR is accessed when the word BEARD is presented, the absence of any information within this entry saying that BEAR + D is a word will necessitate the continuation of the lexical search until the correct entry for BEARD is located.

To state more clearly what is meant by "lexical representation" or "lexical entry" in this context, consider the model of the lexicon proposed by Forster (1976). Forster's system involves two conceptually distinct types of storage files. He proposes that all information about every word in a person's vocabulary is stored in a "*master file*" or lexicon proper, and this information is retrieved via one of three *peripheral access files:* orthographic, phonological, and semantic. For *visual* word recognition the orthographic access file is employed. Every entry in this access file provides the "address" of the entry for a word in the master file. An analogy can be drawn between this system and a library. The master file can be seen as the books in the library while the peripheral files are like the author or title index. On the basis of this model, the question of how one recognizes a printed word becomes a question of how words are represented and retrieved from the orthographic file. Therefore, what I have previously termed "lexical representations" can now be considered as the representations in the orthographic access file. Thus the entries in the orthographic file are representations of the BOSSes of words. Information about the full spelling of the word could only be determined from the entry for the word in the master file. So, the claim that CANDLE is represented as CAND in the lexicon does not mean to imply that the full spelling of CANDLE is not stored at all. What it means is that all information about CANDLE (orthographic, phonological, semantic) is stored but that this information is accessed through an orthographic code, namely CAND, when the word is presented visually.

The results presented here strongly support the idea that lexical access is carried out on the basis of the orthography of the visually presented word, with no phonological encoding taking place. There is, however, contrary evidence from other studies suggesting that there is phonological mediation in visual word recognition. How can one account for these findings while still maintaining the BOSS notion? The two most influential studies that present evidence in favor of phonological encoding are those by Rubenstein, Lewis, and Rubenstein (1971) and Meyer, Schvaneveldt, and Ruddy (1974).

Rubenstein et al. present two types of evidence to support phonemic recoding. First, homophonic words (e.g., SALE) and homophonic nonwords (e.g., BRANE) were found to take longer to classify in a lexical decision task than control items, and second, pronounceable illegal nonwords (e.g., TUFK) were found to take longer to classify than unpronounceable ones (e.g., TUBW). While the homophonic nonword result has been replicated (Coltheart, Davelaar, Jonasson, & Besner, 1977), and so has the illegal nonword result (Rubenstein, Richter, & Kay, 1975), the homophonic word result has failed to be replicated (Coltheart et al., 1977) and seems to have simply been a product of the statistical analysis employed (Clark, 1973). So it appears from this that phonological encoding does occur, but only with nonwords. Perhaps it is employed as a back-up for direct orthographic access, only coming into play when no appropriate lexical entry is located via direct access. The evidence presented by Meyer, Schvaneveldt, and Ruddy, however, is based on word items rather than nonword items.

Meyer et al. demonstrated that in a double word lexical decision task, rhyming pairs of words (e.g., BRIBE TRIBE) were recognized more quickly than control pairs (e.g., BRIBE HENCE), while nonrhyming pairs which were nevertheless orthographically similar (e.g., COUCH TOUCH) were recognized more slowly than control pairs (e.g., COUCH BREAK). Thus it seemed that the fact that the words were phonologically similar outweighed the fact that they were orthographically similar and, therefore, that phonological encoding was taking place in word recognition. A recent study by Shulman, Hornak, and Sanders (1978), however, has

revealed that when the distractor items used in the task are illegal nonwords (unlike the legal nonwords used by Meyer et al.), the fact that the orthographically similar pairs do not rhyme does not influence response times. That is, with illegal nonwords as distractors, items like TOUCH COUCH are responded to just as quickly as items like BRIBE TRIBE, both being faster than control items. From this, Shulman et al. suggest that the effect observed by Meyer et al. was a result of some phonologically mediated short-term memory strategy coming into play when the task was made more difficult by increasing the similarity between the words and the nonwords. It certainly appears that phonological encoding can be carried out, but there is now little evidence to say that it is carried out in order to recognize a word in the normal lexical access situation.

Of course, it is possible that the data presented here in favor of nonphonologically mediated access result from some strategy adopted by the subjects also, though what sort of strategy this might be is hard to say. There is, as yet, no evidence available on which to evaluate this possibility.

Appendix

Below are listed the items used in Experiment 2, together with the mean lexical decision time for the item.

Items are presented in their O-Group form followed by their P-Group form. N-Group items are presented after all the O-Group and P-Group items.

Words

CRUCial	596,	CRUcial	644;	argUE	604,	arGUE	616;
silvER	536,	silVER	595;	MOVie	554,	MOvie	553;
TEXTile	564,	TEXtile	615;	VICTim	559,	VICtim	554;
gentLE	540,	genTLE	564;	entRY	574,	enTRY	510;
CANCer	526,	CANcer	609;	stadIUM	650,	staDIUM	663;
tractOR	589,	tracTOR	575;	CIRCuit	554,	CIRcuit	602;
genIUS	590,	geNIUS	577;	whiskY	549,	whisKY	527;
EMPire	545,	EMpire	586;	RADar	668,	RAdar	645;
marbLE	586,	marBLE	634;	bordER	561,	borDER	678;
VERBal	634,	VERbal	582;	VIRTue	588,	VIRtue	605;
pupIL	577,	puPIL	537;	furnISH	628,	furNISH	606;
PRESTige	565,	PREStige	601;	EAGer	599,	EAger	607;
pistOL	507,	pisTOL	612;	mutUAL	562,	muTUAL	615;
CLIMate	578,	CLImate	596;	cycLE	547,	cyCLE	628;
powdER	639,	powDER	586;	FORTune	584,	FORtune	618;
zerO	535,	zeRO	610;	nobLE	609,	noBLE	630;
STUPid	587,	STUpid	519;	CRYSTal	598,	CRYStal	610;
PLASTer	537,	PLASter	543;	destINY	576,	desTINY	562;
SPONSor	547,	SPONsor	611;	protEIN	547,	proTEIN	584;
URGent	562,	URgent	558;	MUSTard	580,	MUStard	615;
bundLE	558,	bunDLE	643;	splendID	575,	splenDID	580.
BLANKET	518;	divorce	531;	merit	599;	colony	624;
LESSON	548;	cellar	542;	BULLET	543;	LEGEND	580;
ADULT	499;	BARREL	592;	widow	535;	rigid	538;

flower	512;	TRIBUTE	589;	settle	526;	HUNGRY	528;
savage	557;	PANIC	520;	GLORY	544;	luxury	565;
gather	546;	CHAPEL	565.				

Nonwords

ampOW	681,	amPOW	628;	glastID	690,	glasTID	681;
BLUNDin	682,	BLUNdin	651;	DAVer	597,	DAver	660;
bralkO	627,	bralKO	577;	DARPle	635,	DARple	630;
padONY	617,	paDONY	633;	CAVure	669,	CAvure	635;
THANDer	632,	THANder	650;	PRANSon	589,	PRANson	671;
gavIAL	643,	gaVIAL	678;	BURNip	679,	BURnip	666;
spadOR	639,	spaDOR	674;	rascOLP	590,	rasCOLP	598;
noodATE	634,	nooDATE	683;	FRAGer	629,	FRAger	610;
lobEN	615,	loBEN	600;	SILPonth	622,	SILponth	597;
FLENDin	600,	FLENdin	623;	GOMen	663,	GOmen	615;
ompIE	682,	omPIE	700;	TANDle	663,	TANdle	616;
prustIN	653,	prusTIN	621;	dringA	621,	drinGA	662;
ramONY	660,	raMONY	683;	spotAR	634,	spoTAR	608;
LATire	606,	LAtire	605;	sunAL	672,	suNAL	662;
CHIMBer	718,	CHIMber	726;	FRIMPon	602,	FRIMpon	622;
BASTop	628,	BAStop	676;	biscORP	694,	bisCORP	663;
BLATer	649,	BLAter	679;	feebATE	599,	feeBATE	723;
zabLE	591,	saBLE	590;	RALParch	608,	RALparch	630;

GRONDIN	664;	RIBEN	613;	umpue	669;	frestid	623;
plandi	615;	serody	643;	HEMPLE	680;	crodar	684;
CATULE	671;	SHENKER	632;	hureal	625;	BLENTON	617;
LASKIP	599;	toscarp	632;	moolite	682;	naten	621;
RITER	647;	VOLPENCH	588.				

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