Short Research Article

Coda Optimization in the Segmentation of English Polysyllabic Letter-Strings

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Abstract. A word-spotting experiment is reported whereby participants determined whether a polysyllabic pseudoword began with a real word or not. All target words ended in a single consonant (e.g., *slam*) which either did or did not form a complex coda with the consonant that followed it. When it did (e.g., the *mp* of *slampora*), target detection was harder than when the target was followed by a vowel (e.g., *slamorpa*). When it did not (e.g., the *mc* of *slamcora*), target detection was easier. These results demonstrate a bias toward maximization of the coda when segmenting a polysyllabic letter-string which is argued to reflect the way in which polysyllabic words are represented in the mental lexicon.

Keywords: lexical processing, polysyllabic words, syllables, visual word segmentation, word recognition, word spotting

Many words that we read in English are polysyllabic, despite being monomorphemic (e.g., *certain*, *cactus*, *umbrella*, *vampire*), and the question can be raised as to how such orthographically complex words are recognized. If they are represented and accessed in lexical memory in terms of their component syllables (e.g., Spoehr & Smith, 1973; Taft & Forster, 1976), it needs to be established how they are structured syllabically. This is the focus of the present research.

In languages whose pronunciation has unambiguous syllable boundaries, like Spanish, it is apparent that orthographic syllable structure corresponds to these phonological boundaries (e.g., Álvarez, Carreiras, & Perea, 2004; Álvarez, Carreiras, & Taft, 2001; Carreiras, Álvarez, & de Vega, 1993; Taft, Álvarez, & Carreiras, 2007). Such a phonologically-based syllabic analysis complies with a principle whereby the consonantal onset of the second syllable is maximized (e.g., Fallows, 1981; Pulgram, 1970; Spoehr & Smith, 1973). For example, the Spanish word *cactus* is divided into the syllables *cac* and *tus*, ensuring that the second syllable begins with a consonant (i.e., the onset *t*).

When it comes to the processing of a language such as English that is not so transparent in its relationship between orthography and phonology, it has been proposed that orthographic syllabification is based on principles other than pronunciation, namely, the Basic Orthographic Syllabic Structure, or "BOSS" (e.g., Chateau & Jared, 2003; Chen & Vaid, 2007; Taft, 1979, 1987, 1992, 2001, 2002; Taft et al., 2007; Taft & Kougious, 2004; Taft & Krebs-Lazendic, 2013). In contrast to the maximal onset principle described above, the BOSS adopts a principle of maximal coda whereby the information conveyed by the first syllable is optimized by including all the consonants after the vowel that can form a legal coda (thus dividing *cactus* into *cact* and *us*).

The evidence favoring the BOSS over an orthographic unit corresponding to the spoken syllable (henceforth referred to as the "Syllable") has come primarily from lexical decision experiments where English polysyllabic words are presented with either their BOSS or their Syllable differentiated from the rest of the word (e.g., Chen & Vaid, 2007; Taft, 1979, 1987, 2001, 2002; Taft et al., 2007). These studies indicated that the BOSS items were easier to recognize than the Syllable items (e.g., *cert-ain* vs. *cer-tain*). However, such a result has not always been observed (see Katz & Baldasare, 1983; Lima & Pollatsek, 1983), suggesting that BOSS representation is not universal. In fact, on the basis of correlations with reading performance, it has been argued that maximization of the coda is a characteristic of better readers only (Taft, 2001, 2002; Taft et al., 2007, but see Perry, 2013).

If it is the case that a polysyllabic word is stored in lexical memory in terms of its BOSS, one might assume that a letter-string (e.g., *certain*) must be divided after its maximized coda prior to lexical retrieval in order that its structure coincides with the stored representation (i.e., *cert*). That is, the letters might be initially identified as consonant or vowel (e.g., Acha & Perea, 2010; Carreiras, Vergara, & Perea, 2009; Lee, Rayner, & Pollatsek, 2001, 2002) and the coda status of any consonants immediately following the

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first vowel then established, hence allowing maximization of the coda.

The experiment to be reported here examines whether there is such a bias toward maximization of the coda when segmenting an English letter-string, and does so by adopting a "word-spotting" task. This task has been previously used in the speech recognition domain to establish how the speech signal is segmented (see McQueen, 1996, for an overview). In the visual version of the task, a polysyllabic pseudoword is presented and participants must decide by key-press whether it begins with a real word (e.g., *slamorpa*) or not (e.g., *tremelth*). Speed and accuracy are measured. A comparison can then be made between items whose target is followed by a vowel (e.g., the *slam* of *slamorpa*) and items whose target is followed by a consonant that can create a complex coda (e.g., *slampora*). If maximization of the coda takes place, it should be easier to detect the target word when followed by a vowel than when followed by a consonant. In the latter case, the target is obscured within the unit that dominates segmentation (i.e., *slamp*), whereas it corresponds to that unit in the former case (i.e., *slam*).

Note that such an outcome would have to be explained in terms of orthographic rather than phonological structure. When polysyllabic utterances are produced, the syllable boundary is always placed within a medial consonant cluster (giving "*slam-pora*"), hence isolating the target, while the boundary may or may not be placed between a singleton consonant and its following vowel depending on the stress pattern assigned to the letter-string (giving either *slam-orpa* or, more likely, *sla-morpa*). Thus, phonological considerations would, if anything, favor *slampora* items over *slamorpa* items in the word-spotting task, which is the opposite of the prediction based on coda maximization.

Even if *slampora* items were shown to be relatively difficult, however, it could still be argued that it does not necessarily support coda maximization. An alternative possibility is that separating two consonants from each other (e.g., *m* and *p*) is simply harder than separating a consonant from a vowel (e.g., *m* and *o*). Such an argument was made by Cutler, Norris, and Williams (1987) in relation to the segmentation of speech. In a rejoinder to a study by Taft and Hambly (1985) who claimed to support the use of the BOSS in spoken word recognition, Cutler et al. (1987) demonstrated that the relative difficulty in detecting a syllable when followed in the utterance by a consonant was unrelated to whether that consonant could be absorbed to form a complex coda (e.g., /mp/) or not (e.g., /mk/). So it may be the case that a word that ends in a consonant is hard to spot merely when followed by another consonant and not specifically when those two consonants can combine to form a complex coda.

This is tested in the present word-spotting experiment by comparing the *slampora* condition to an additional condition where the consonant following the target word does not form a complex coda (e.g., *slamcora*, where *mc* is not a valid coda). If the mere adjacency of consonants is enough to obscure an embedded target word, it should be equally hard to detect that word for both of these conditions relative to the condition where the consonant is followed by a vowel (e.g., *slamorpa*). However, if maximization of the coda takes place during syllabic segmentation, the *slampora* condition should be the most difficult.

Given the suggestion that BOSS representation might be more characteristic of better than poorer readers (e.g., Taft, 2001, 2002; Taft et al., 2007), a reading comprehension test was also administered to establish whether better reading was associated with greater difficulty in detecting targets in the *slampora* condition relative to the *slamorpa* condition. In order to strengthen the probability of detecting such a relationship if it were to exist, a large number of participants were tested.

Method

Participants

Ninety students from the University of New South Wales participated in the experiment for course credit. All were native speakers of English and had normal or corrected-to-normal vision.

Materials

Target items were 36 monosyllabic words that ended in a single consonant which could potentially be the first consonant of a complex coda (i.e., primarily a nasal or approximant). The words were either of three or four letters in length (mean length of 3.53), and ranged in frequency from 0.61 per million (*loin*) to 516 per million (*far*) according to the CELEX norms of Baayen, Piepenbrock, and van Rijn (1993), with a mean frequency of 44.6 per million.

Four or five letters were added to the end of these words in order to create the experimental pseudowords with three types of boundary. In the first condition, the added letters started with a consonant that created a possible complex coda when combined with the final consonant of the embedded word (e.g., *pora* was added to the word *slam* resulting in *slampora*, where *mp* can be a complex coda). Potential as a coda was defined in terms of whether the consonant combination could be found in the final position of a monosyllabic word (cf. *jump*). The grapheme following the target did not produce an initial word fragment when added to the target (e.g., there are no words beginning with *slamp*). With reference to the function of the grapheme that followed the target word, this condition will be labeled the "Coda" condition.

The letters that were added to the target in the second condition started with a vowel (e.g., *orpa* was added to *slam* resulting in *slamorpa*) and, hence, was labeled the "Vowel" condition. The element that was added to each target was of the same length as in the Coda condition, and had at least some of the same letters. As in the Coda condition, the grapheme following the target did not produce an initial word fragment when added to the target, except for the occasional inflected form of the target (e.g., there are no words beginning with *slamo*). The mean bigram frequency was matched with that of the Coda condition (according to the CELEX norms) for both the type measure (40.68 vs. 37.94, for Vowel and Coda, respectively) and the token measure (357.37 vs. 314.85), p's > 0.1.

The pseudoword items in the final condition were identical to those in the Coda condition except that the consonantal onset of the added element could not form a complex coda when attached to the final consonant of the target word. For example, the *p* of *slampora* was replaced by a *c* to created *slamcora*, where *mc* is not a possible coda and, therefore, has to be treated as a simple coda plus onset (cf. *tomcat*). This was the "Onset" condition. The mean bigram frequency for this condition (32.34 for the type measure; 275.18 for the token measure) was significantly lower than for both the Coda condition, p's < .01, and the Vowel condition, p's < .05.

All experimental items can be found in the appendix.

Three counterbalanced sublists were generated within a Latin Square design such that a third of the pseudowords were presented to one subgroup of participants in the Coda condition, a third in the Vowel condition, and a third in the Onset condition, with the items being rotated through the three conditions for the other two subgroups. In this way, all participants received 12 items in each condition without any targets being repeated and, across the three subgroups, all targets were presented under each condition.

The existence of the Onset and Vowel conditions had the potential to bias the participants toward adopting the first medial consonant as a simple coda in the Coda condition. To counteract this possibility, an additional set of 18 filler pseudowords was included in each sublist where the target word unambiguously ended in a complex coda (e.g., *harmula*, *limbrune*, *hauntiol*).

The 54 items requiring a "yes" response in each sublist were supplemented by a set of 54 distractor pseudowords that did not begin with a real word, hence requiring a "no" response. These were of the same structure as the "yes" items, with 18 having a complex medial coda (e.g., *grunkeft*, *gontalga*, *larpent*), 18 having a single medial consonant (e.g., *tremelth*, *blawunky*, *rinatch*), and 18 having two medial consonants that formed a simple coda plus onset (e.g., *tesrune*, *jomharue*, *swinprag*).

Procedure

The task was "word-spotting." The pseudowords were presented in the center of a computer screen and participants had to decide whether or not a real monosyllabic word appeared at its beginning. Participants were told to respond as quickly but as accurately as possible by pressing one of two keys, labeled "YES" or "NO." All items were presented in a different random order for each participant with a display duration of 500 ms. A new trial was initiated 500 ms after the participant made their response or after 3,000 ms if no response was made. Reaction times (RT) and error rates were measured. A practice session was carried out prior to the test items, consisting of 10 pseudowords, half of which began with a real word and half of which did not.

After completing the experiment, all participants were given a paper-and-pencil reading comprehension test which comprised a series of short passages each followed by three to seven multiple choice questions. This was the same test that was used by Taft (2001, 2002) and Taft et al. (2007), and was based upon the Co-operative Reading Comprehension Test developed by the Australian Council of Educational Research (ACER). In all, there were 57 multiple choice questions coming from a total of 12 passages, each with five alternative answers. A time limit of 15 min was tightly adhered to and participants were told that they were not expected to complete the whole test, but that they should work as rapidly as possible without making careless mistakes.

Results

As pointed out by McQueen (1996), the word-spotting task produces quite a high error rate, with the target being missed more than 20% of the time in the present study. With such a difficult task, there turned out to be seven participants who made more than 50% errors overall, and their data were removed prior to the analyses on the grounds of potential unreliability.

Mean RT and error rates (see Table 1) were analyzed using linear mixed effects modeling (Baayen, Davidson, & Bates, 2008; Bates, 2005), which simultaneously takes participant and item variability into account. Analysis of the error data made use of the logit function for binomial data. The analyses were performed using the R statistics software with the package lme4 (Bates & Maechler, 2009). The factor conditions (Coda, Vowel, and Onset) were compared within-group for both the participant and item analyses, while the three sublists required by the Latin Square design were included as a between-group factor. However, the data for the sublist factor are not reported because they are theoretically meaningless, simply being a measure of how evenly the items were distributed to the three subgroups in terms of their extraneous characteristics.

Analyses of RT were carried out only for correct responses after those exceeding two standard deviations above or below the mean for each participant were replaced by that cut-off value (4.4% of responses). Three participants

Table 1. Mean word-spotting latencies (RT in ms) and % error rates for the participant data arising from the Coda, Vowel, and Onset conditions

	Coda	Vowel	Onset
Example	*slampora*	*slamorpa*	*slamcora*
RT	858	820	801
Error rate	37.8%	28.4%	23.4%

Note. Mean latency for the no target distractors was 933 ms with a 13.1% error rate.

were rejected from the RT analysis (but not the error rate analysis) because they made over 66% errors in at least one of the conditions, hence weakening the reliability of the mean RT for that condition. Three sets of item RTs were also removed from the analysis because of their very high error rate (namely, the three cases where the target was detected less than 20% of the time in at least one of the pseudowords in which that target occurred: *yen*, *fir*, and *gem*).

The Condition factor was significant both for RTs, $\chi(1) = 87.51$, $p < .001$, and for error rates, $\chi(1) = 387.09$, $p < .001$. The post hoc analyses showed that the Coda condition proved to be more difficult than the Vowel condition as measured in terms of both speed, $t = 3.32$, $p < .001$, and accuracy, $z = 5.80$, $p < .001$, as well as being more difficult than the Onset condition, $t = 5.55$, $p < .001$, and $z = 7.18$, $p < .001$, for speed and accuracy, respectively. In addition, the Onset condition was associated with shorter latencies than the Vowel condition, $t = 2.32$, $p < .05$, as well as having fewer errors, though not significantly, $z = 1.45$, $p > .1$.

Finally, a correlation was carried out between performance in the ACER reading test and the magnitude of the boundary effect (i.e., Coda minus Vowel). Following Taft (2001) and Taft et al. (2007), the measure of reading was the number of correctly answered questions (with scores ranging from 5 through to 42, and a mean of 15.90), while the magnitude of the boundary effect used *z*-scores calculated separately for each of the three subgroups of participants to take into account the fact that their means were based on a different distribution of items. In addition, the RT difference was treated as a ratio to the overall mean RT for each participant.

There was clearly no correlation for the RT measure, $r(80) = -.074$, but at least a suggestion of one for the ER measure, $r(83) = 0.180$, $p = .1$. Looking factorially in a post hoc ANOVA at the relatively good and relatively poor readers, neither a median split nor tertile split showed an interaction between the magnitude of the boundary effect on error rates and reading ability, $F_1(1, 77) = 1.89$, $MSE = 148.57$ and $F_1(1, 48) = 1.46$, $MSE = 92.77$, respectively. However, such an interaction did turn out to be significant when only the participants at the very extremes of the reading continuum (the upper and lower quintile) were examined (i.e., those with greater than 20 correct, $n = 17$, vs. those with less than 10 correct, $n = 16$), $F_1(1, 27) = 4.48$, $MSE = 96.04$, $p < .05$. Error rates for the upper quintile were 36.96% and 26.14% for the Coda and Vowel conditions respectively (i.e., a significant advantage for the Vowel condition of 10.82%, $F_1(1, 14) = 7.60$, $p < .02$), while for the lower quintile they were virtually identical for the two conditions: 31.32% and 31.28% respectively ($F < 1$).

Discussion

It is clear from the results that a word ending in a consonant (e.g., *slam*) is harder to detect when it can be combined with the consonant that follows it to form a complex coda (as in *slampora*) than when followed by a vowel (as in *slamorpa*) or another consonant that does not create a complex coda (as in *slamcora*). This can be readily explained in terms of a segmentation mechanism that maximizes the possible coda of the first syllable of a polysyllabic letter-string. So, priority in processing is given to the unit with a maximized coda (e.g., *slamp* in *slampora*) over the smaller unit that corresponds to the target word. This makes the target harder to detect relative to cases where maximization of the coda isolates the target word itself, namely, when the target is followed by a vowel (*slamorpa*) or a consonant that can only be the onset of the next syllable (*slamcora*).

Bias toward a maximal coda is consistent with the proposal that polysyllabic words are structured in lexical memory in terms of their BOSS, a unit that maximizes the coda of the first syllable (e.g., Chateau & Jared, 2003; Chen & Vaid, 2007; Taft, 1979, 1987, 1992, 2001, 2002; Taft et al., 2007; Taft & Kougious, 2004; Taft & Krebs-Lazendic, 2013). There would be little purpose in maximizing the coda when segmenting letter-strings if that analysis did not coincide in some way with the way representations are stored. However, while it appears that coda maximization dominates coda minimization (or onset maximization) when analyzing English letter-strings, it is unclear what the specific nature of the segmentation mechanism might be.

One possible account is that the initial segmentation is based on the identification of the maximal coda, but if no word is accessed via this analysis, the minimal coda structure is then tried out as a backup. Such an account would explain the faster and more accurate responses to the Vowel items relative to the Coda items in the word spotting experiment because the target would only be accessed in the latter condition after the backup mechanism came into play. This account describes "larger-to-smaller" segmentation since the analysis begins with a maximal unit (e.g., *slamp* in *slampora*) and, when this is not found to have a representation in lexical memory, reverts to the smaller unit (*slam*). Alternatively, both sized units might be tried out in parallel, but if so, the larger unit would still have to have priority over the smaller unit or else the difficulty in detecting the target in the Coda condition could not be explained.

The alternative account is "smaller-to-larger" segmentation; that is, a reiterative "left-to-right" technique like that proposed by Taft (1979, see also Libben, 1994). Here, an attempt is made at accessing increasingly larger units starting from the beginning of the letter-string. Even though *slam* will be tried out prior to *slamp* when the Coda pseudoword *slampora* is presented, it is still possible to explain why the smaller unit is not detected as efficiently as in a Vowel pseudoword (*slamorpa*). If the successive attempts at segmentation are cascaded, the processing of *slamp* would begin prior to the processing of *slam* being completed, and the latter might then be inhibited by the greater potential of the former to succeed in accessing a representation. That is, when two medial consonants form a complex coda, it is far more likely that the unit that ends in this coda corresponds with a stored representation than the unit that ends in only the first of those consonants. The latter will only be the appropriate segmentation in those rare cases, like *starlet*, where the stored representation is structured on morphemic principles (e.g., *star-let*) rather than with a maximized coda (i.e., *starl-et*). Hence, if it is possible to generate a segmentation unit with a complex coda, this will be given priority over any smaller segmentation units.

The smaller-to-larger account is consistent with the interference to lexical decision responses observed by Taft (1979) from a word embedded at the beginning of a letter-string (e.g., *starl*) and not elsewhere (e.g., *blean*). Apart from plural *-s* (and possibly past tense *-t*), there are no monosyllabic English words that would be recognized on the basis of an initial subset of letters as opposed to the whole word, which means that there would be no reason to activate lexical information on the basis of such a subset even when the letter-string fails to activate a word as a whole unit (as in the case of a nonword like *starl*). Therefore, the only reason for interference from the lexical status of the initial subset of letters would seem to be if the smaller unit was activated during the course of segmentation, namely, via left-to-right processing.

However, the findings of Taft (1979) still need confirmation. Bowers, Davis, and Hanley (2005) present data that are inconsistent with a left-to-right segmentation account. In particular, they observed interference from embedded words in a semantic judgment task regardless of position (e.g., being slower to say that *grump* is not an alcoholic drink than to say it is not a piece of clothing as a result of the existence of *rum* embedded within it). Nevertheless, there was some suggestion in their error data that interference might have been stronger for initial embedding. So, until there is more definite empirical evidence against left-to-right segmentation, it remains a viable account even if a larger-to-smaller segmentation procedure provides a more natural explanation of the present word-spotting data.

One thing that is clearly shown in the present experiment is that the difficulty in detecting the target in the Coda condition cannot be explained merely in terms of difficulty separating two consonants. It mattered that the consonant following the target formed a potential coda with the final consonant of the target. When it did not, as in the Onset condition (e.g., *slamcora*), the target was easier to detect than when it did (*slampora*). This is different to what Cutler et al. (1987) found using spoken materials, where the detection of a syllable was equally difficult regardless of whether a coda could be created with the consonant following the target. However, the syllable-spotting task used by Cutler et al. (1987) required the identification of a unit that was demarcated in the physical signal (i.e., the unit preceding the phonetically-defined syllable boundary). Therefore, the impact of adjacent consonants in that task is likely to have arisen from processing of the acoustic signal, a factor that is not relevant when the stimulus is presented visually.

The fact that word spotting was easier in the Onset condition than the Vowel condition of the present study needs an explanation. One possibility would seem to lie in the involvement of phonology when performing the task in relation to the possible pronunciation given to the pseudoword. Take *slamcora* versus *slamorpa*, for example. When read aloud, the first syllable of the former unambiguously coincides with the pronunciation of the target (i.e., /slæm/), but not necessarily so in the latter case. As with a number of the Vowel pseudowords, stress may well be placed on the second syllable, which not only positions the syllable boundary within the target word (e.g., *sla-morpa*), but reduces the first vowel to a schwa. Therefore, the target might be obscured by such phonological considerations at least some of the time for those items.

However, it must be emphasized that a phonological basis cannot be given for the critical comparison between the Vowel and Coda conditions. In terms of pronunciation, the target always coincides with the first syllable of the Coda pseudoword (e.g., "*slam-pora*"), as is the case for Onset pseudowords. Yet, despite this, the target is harder to detect than in the Vowel pseudoword. Therefore, while phonology might be activated in the course of performing the word-spotting task, the difficulty with the Coda condition cannot be ascribed to such activation. It seems that maximization of the orthographic coda is so dominant in segmentation that it often obscures the target when it coincides with the phonologically-based syllabification.

Another possible explanation for the advantage of the Onset condition over both the Vowel and Coda conditions might be drawn from the fact that its mean bigram frequency was significantly lower than that of the other two conditions. The existence of a steep gradation in bigram frequency might signal a segmentation boundary (cf. Seidenberg, 1987). The problem with such an account, however, is that it cannot explain the difference between the Coda and Vowel condition because they were matched on bigram frequency. Therefore, bigram frequency per se cannot be the basis for segmentation. Instead, the lower bigram frequency of the Onset condition is simply indicative of the fact that the two medial consonants combine less often than in the Coda condition, which was the basis for defining those two conditions in the first place. In other words, it is immaterial whether one defines the difference between the Onset and Coda conditions in terms of the frequency with which their medial consonants combine or in terms of whether those two consonants form a complex coda. Either way, the critical finding that word-spotting is harder in the Coda condition than in the Vowel condition cannot be explained merely in terms of difficulty in separating two consonants.

Finally, the idea that coda maximization is a feature of more proficient reading finds only very weak support in the present study. The evidence for better readers having greater relative difficulty with the Coda items than poorer readers comes only when considering the very extremes of the reading ability continuum and only in relation to accuracy. While it is interesting that, as predicted, it is the better readers who show the relatively poorer performance, the overall correlation between reading ability and boundary effect is so weak that it throws doubt on any claims about different reading strategies being associated with different reading levels. It is either the case that readers of all levels of proficiency make similar use of phonological information when performing the word-spotting task, or that they are equally biased toward maximizing the coda of the first syllable when segmenting English polysyllabic letter-strings.

Conclusions

The present study supports the idea that the internal analysis of polysyllabic letter-strings is biased toward maximization of the coda following the first vowel (e.g., segmenting *slampora* after the *p*). This is seen in the relative difficulty detecting a word that is a subset of the maximized unit (e.g., the *slam* of *slamp*), despite that word corresponding to the phonological first syllable (as in *slam-pora*). Such a result is consistent with the idea that the coda of a polysyllabic letter-string is maximized in order that it corresponds with the primary access unit if that letter-string were a word. By this argument, a polysyllabic word would be recognized via a unit that maximizes its medial coda, namely, its BOSS (e.g., the *vamp* of *vampire*). According to this logic, then, the present study potentially provides evidence for the mechanisms involved in normal reading performance despite the relative artificiality of the word-spotting task.

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Appendix

The following are the items used in the experiment presented in triplets ordered by condition: Coda, Vowel, Onset.

slampora, *slamorpa*, *slamcora*; *vangote*, *vanotch*, *vanhote*; *pankelt*, *panilok*, *panwelt*; *farchupt*, *faruchep*, *farjupt*; *scardisp*, *scaripse*, *scarjisp*; *tarkess*, *tarense*, *tarhess*; *jartesk*, *jarensk*, *jarwesk*; *gaskume*, *gasuime*, *gasrume*; *pawlanth*, *pawainth*, *pawganth*; *clawniry*, *clawonry*, *clawfory*; *raintule*, *rainudle*, *rainbule*; *gempilon*, *gemiplon*, *gemrilon*; *yendomp*, *yenonge*, *yenlomp*; *hentoid*, *henourd*, *henpoid*; *chewdoan*, *chewoand*, *chewvoan*; *gearnift*, *gearinst*, *gearwift*; *pignard*, *pigaund*, *pigfard*; *slimponge*, *slimongth*, *slimdonge*; *thindany*, *thinandy*, *thinrany*; *ginkuth*, *ginurth*, *ginputh*; *stirmuze*, *stirunze*, *stirjuze*; *firtaim*, *firaist*, *firwaim*; *sondreen*, *soneetin*, *sonbreen*; *lowniat*, *lowiant*, *lowgiat*; *crowlidge*, *crowirsth*, *crowpidge*; *lointrafe*, *loinarfte*, *loinprafe*; *noundiler*, *nounitler*, *nounriler*; *soardace*, *soaralce*, *soarhace*; *drumplin*, *drumiolp*, *drumglin*; *runkobe*, *runorbe*, *runcobe*; *spintulow*, *spinuclow*, *spinhulow*; *furfutch*, *furuetch*, *furjutch*; *slurnast*, *sluranct*, *slurhast*; *plustoin*, *plusoint*, *plusboin*; *plothiga*, *ploticha*, *plotciga*; *spitchano*, *spitachno*, *spitquano*