Cross-language differences in the use of internal orthographic structure when reading polysyllabic words

Marcus Taft, Carlos J. Álvarez and Manuel Carreiras
University of New South Wales, Sydney, Australia / University of La Laguna, Tenerife, Spain

The way in which adult readers process the internal orthographic structure of words was examined in two languages that differ in their syllabic structure, English and Spanish. Readers of both languages were presented with polysyllabic words split according to either their pronounced syllable (e.g., *cac tus*) or their maximized initial unit corresponding to their Basic Orthographic Syllabic Structure (BOSS, e.g., *cact us*). In agreement with other recent research, it was found that speed of lexical decision to syllabically split words was faster than to BOSS split words for poorer English speakers, while better English speakers were more oriented toward the BOSS. The Spanish data suggested an overall syllable bias regardless of reading ability, though less so for better readers. The contrast between the English and Spanish results is explained in terms of phonological considerations being more important for Spanish readers.

Keywords: cross-language processing, lexical processing, orthographic processing, polysyllabic words, syllabic processing, reading: Spanish versus English

It has been amply shown that spoken polysyllabic words are analyzed differently depending on the native language of the listener (e.g., Bradley, Sánchez-Casas, & García-Albea, 1993; Cutler, Mehler, Norris, & Segui, 1986; Sebastián-Gallés, Dupoux, Segui, & Mehler, 1992). In particular, speakers of languages with clear-cut syllable boundaries (e.g., Spanish and French) seem to use the syllable as a unit in the processing of spoken polysyllabic words, whereas speakers of English show little evidence of this. The issue being addressed here is whether such inter-language differences also exist when the polysyllabic words are read. It is not the case that orthographic processing units have to coincide with the spoken processing

The Mental Lexicon 2:1 (2007), **49–63**.
ISSN 1871–1340 / E-ISSN 1871–1375

units, so it does not necessarily follow that Spanish or French readers show syllabic analysis in reading while English readers do not.

There is evidence, though, that Spanish readers are indeed sensitive to syllable structure when reading silently. For example, Spanish words with common first syllables take longer to recognize as words (i.e., in a lexical decision task) than those with rarer first syllables (e.g., Álvarez, Carreiras, & De Vega, 2000; Álvarez, Carreiras, & Taft, 2001; Carreiras, Álvarez, & de Vega, 1993; Perea & Carreiras, 1998), and this is explained in terms of competition arising between words that share their first syllable. Whether we can say that English readers, in contrast, do not make use of syllable structure appears to be a more complex issue.

While there are no reports of experiments examining syllable frequency effects in reading English, there are experiments that contrast the syllable to another unit that is of potential importance in reading. In particular, the analysis of a printed word into its spoken syllable structure maximizes the number of consonantal onsets in a word (e.g., the spoken syllable structure of *cactus* assigns the *t* to the onset position of the second syllable, giving *cac-tus*), whereas the unit with which it can be contrasted, the Basic Orthographic Syllabic Structure or BOSS (e.g., Taft, 1979, 1986, 1987, 1992, 2001, 2002), maximizes the size of the consonantal coda of the first syllable (e.g., the BOSS of *cactus* is *cact*, whereby the *t* becomes part of the final consonantal grouping, or coda, of the initial unit). Taft concluded from his earlier work (Taft, 1979, 1987) that the BOSS is the optimal unit of processing for native adult English readers rather than the syllable, because words physically split in terms of a BOSS analysis (e.g., *cact us*) were easier to recognize than those split in terms of their spoken syllable structure (e.g., *cac tus*).

More recently, however, Taft has presented evidence to suggest that this may only be true for better readers and that poorer adult readers may actually favor a syllabic analysis (Taft, 2001, 2002). In particular, the response latency advantage for the BOSS division over the syllable division was found to correlate with reading performance (as measured independently using a multiple-choice reading comprehension test) and, further, that a comparison of those in the top and bottom quartiles of reading performance pointed to a BOSS advantage for the better readers and a syllable advantage for the poorer readers.

The indications at this stage, then, are that the optimal processing of internal orthographic structure in English maximizes the coda of the first subunit, that is, it follows a BOSS analysis. Use of spoken syllable structure appears to be associated with poorer reading in English, even though it may be optimal in Spanish. While reading ability has not been examined in the studies of Spanish syllabic processing, the involvement of the syllable has been consistently shown even when this factor is ignored, which suggests that Spanish readers at all levels of proficiency make use of the syllable. Furthermore, attempts at revealing any involvement of a

BOSS analysis in Spanish have been unsuccessful (Álvarez et al., 2001; Sánchez-Casas, 1996). Álvarez et al. (2001) did find that a word with a high frequency BOSS was recognized more quickly than one with a low frequency BOSS (when controlling for syllable frequency), but it turned out that when the BOSS was teased apart from the root morpheme, it was the latter that led to this frequency effect and not the former.

What is missing, however, is a comparison of Spanish and English within the same paradigm. The aim of the research reported here is to do this in order to directly address the issue of whether optimal Spanish reading involves maximization of the onset (e.g., a *cac-tus* analysis) while optimal English reading involves maximization of the coda (e.g., a *cact-us* analysis). The task employed was the splitting technique previously used in the English experiments of Taft (2001, 2002) along with an equivalent multiple-choice reading comprehension test in English and Spanish.

Experiment 1

In order to directly compare English and Spanish lexical processing, exactly the same set of words was used when testing both the English and Spanish readers. That is, the words that were selected happen to exist in both languages (e.g., *cactus*, *final*, *plaza*). In a few cases, the word was one that has been adopted into English directly from Spanish (e.g., *plaza*, *iguana*), but mostly they were words with a shared historical origin (e.g., *cactus*, *final*). By selecting the same words for each language, orthographic structure was controlled. This means that any difference found between Spanish and English readers would have to have arisen from a difference in their mechanisms for processing orthography rather than a difference in the orthographic structure itself.

The first experiment examines the pattern of responses given by English readers to this set of words. As such, it is an attempt to replicate the findings of Taft (2001, 2002), where native adult English speakers showed no overall difference between response times to BOSS divisions (e.g., *cact us*) and syllable divisions (e.g., *cac tus*), but where divisional preference correlated with reading proficiency, with better readers being relatively more oriented toward a BOSS analysis and poorer readers being more oriented toward a syllable analysis.

Method

Materials and procedure. Forty words were found that had the same orthographic form in English and Spanish (see Appendix). All of these words had a structure

that allowed the differentiation of the spoken syllable from the BOSS via a splitting technique, namely, they had a medial consonant cluster (e.g., *cac tus* versus *cact us*; *car ton* versus *cart on*), a long first vowel (e.g., *fi nal* vs. *fin al*; *pla za* vs. *plaz a*), or an unstressed first syllable (e.g., *ha bitual* vs. *hab itual*; *ma rina* vs. *mar ina*). The structural split was made by means of a two space gap within the word. The words were divided randomly into two lists such that, in each list, half the words were split according to the BOSS and half according to the syllable, with the condition under which each word appeared being counterbalanced across the two lists.

The experimental words were presented in a different random order to each participant interspersed with 40 nonwords that were designed to have a very similar structure to the real words (e.g., *pleta*, *fapon*, *perdal*, *menitiar*). Half of these nonwords were presented with a maximal onset division (equivalent to the syllable: e.g., *ple ta*, *per dal*) while half were presented with a maximal coda division (equivalent to the BOSS: *fap on*, *men itiar*). There were also 12 practice items presented prior to the 80 test items.

Participants were told that they would see a letter-string split into two parts on the screen and were instructed to press a "yes" or "no" button in response to whether or not that letter-string formed a real word when the two parts were combined. They were told to respond as quickly but as accurately as possible. Each item was presented under computer control in lower-case letters on a television monitor for 500 ms with an inter-trial interval of 1 s after the response.

After completing the experiment, the participants were given the same paper-and-pencil reading comprehension test used by Taft (2001, 2002). This test comprised twelve short passages each followed by three to seven multiple choice questions and was based upon the Co-Operative Reading Comprehension Test developed by the Australian Council of Educational Research. There was a total of 57 multiple choice questions, each with five alternative answers to choose from. A time limit of 15 minutes was strictly adhered to and participants were informed that they were not expected to complete the whole test, but should work as rapidly as possible without making careless mistakes.

Participants. The participants were 36 first-year psychology students at the University of New South Wales who received course credit for their participation.

Results and Discussion

In analysing the results, the data from any participant who made more than 30% errors in either of the two conditions was eliminated. Five participants were rejected on this basis. Response times that fell more than 2 standard deviation points away from the mean for the word items for that particular participant were replaced by that 2 standard deviation cut-off value.

The mean response time and error rate for the BOSS division condition was 735 ms and 7.1% respectively while for the syllable division it was 726 ms and 5.9% respectively. Neither the RT nor error difference was significant, all *F*'s < 1.36. However, it was the correlation of reading performance with the BOSS/syllable RT difference that was of most importance.

Following the same procedure as Taft (2001, 2002) a BOSS preference measure was determined for each participant by subtracting their RT for the BOSS condition from their RT for the syllable condition and then calculating the ratio of this difference score to their overall RT for the two conditions. It was apparent from the Taft (2001) study that such a ratio difference score was a more sensitive measure than the absolute difference score, confirming the idea that the difference between, say, 500 ms and 520 ms is more meaningful than the same sized difference between 1100 ms and 1120 ms. Finally, the BOSS preference scores for each of the two groups were converted into *z* scores (using the mean and standard deviation for the relevant group) in order to take into account the fact that each group received a different list of items.

This BOSS preference measure was then correlated with the reading comprehension score which, again following Taft (2001, 2002), was taken as the number of multiple choice questions correctly answered. The reading scores ranged from 5 through to 23 with an average of 14.5 correct, which is lower than the average score obtained in the previous Taft (2001, 2002) studies (around 19 correct). Nevertheless, like those previous studies, the correlation between BOSS preference and reading performance turned out to be significant, $r(31) = .346$, $p < .05$. Figure 1 shows the scattergram for the *z* scores mapped against reading ability.

In the Taft (2001) study the top and bottom quartiles of reading performance were determined from over 100 participants to be 23 or more correct and 12 or

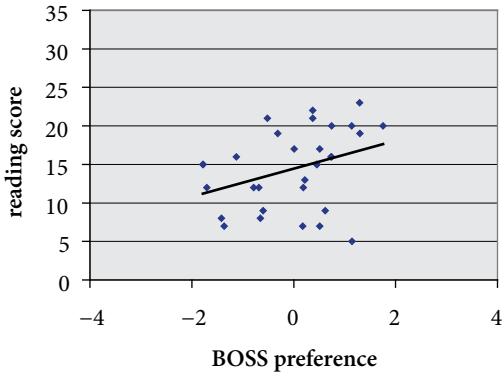

Figure 1. Scattergram for the correlation in Experiment 1 between reading comprehension performance (reading score) and BOSS preference for native English readers.

Table 1. Mean lexical decision times (and error rates in parentheses) for the upper and lower English reading groups in Experiment 1, determined by a median split of reading comprehension scores.

	BOSS e.g., *cact us*	**Syllable** e.g., *cac tus*	**difference**
"Better" readers	701 ms (6.3%)	717 ms (6.2%)	+16
"Poorer" readers	765 ms (8.0%)	739 ms (5.8%)	−26

fewer correct respectively. Such a division was not possible in the current experiment because of the small number of participants, particularly in the upper range. Instead, a median split was undertaken to look at "better" and "poorer" readers. The split was made between 15 and 16 correct, but because there were four participants scoring 15 and three scoring 16, the numbers in the two groups were not even (fourteen better readers and seventeen poorer readers). The means for the median split are given in Table 1.

A post-hoc analysis of these mean lexical decision times was carried out, splitting both the better and poorer readers into their two groups based on the list they received. A significant interaction was obtained between reading ability and divisional preference,[1] $F(1,27) = 7.72$, $p < .01$, which reflected the fact that there was a significant syllable preference for the poorer readers, $F(1,15) = 8.81$, $p < .01$, and a strong trend for a BOSS preference for the better readers, $F(1,12) = 4.02$, $p < .1$. Nothing was significant in the error analyses, all F's < 1.

Such a result confirms the previous findings (Taft, 2001, 2002) that poorer readers are more phonologically oriented than better readers (see also Jared, Levy, & Rayner, 1999; Lewellen, Goldinger, Pisoni, & Greene, 1993) who are, in turn, more oriented toward an analysis that maximizes the informativeness of the first unit (i.e., by maximizing the coda). It seems that observance of spoken syllable structure is not an optimal strategy for reading English.

In Spanish, unlike English, the appropriate syllable structure can be readily generated from orthographic information. For example, the English words *manure* and *mania* both have *ma* as their first syllable (though pronounced differently), while *manage* and *manic* both have *man* as their first syllable. So, one cannot tell from orthography alone which pronunciation is appropriate. On the other hand, all Spanish words beginning with *man* (followed by a vowel) will have their syllable boundary between the *a* and the *n* (e.g., *ma-no*, *ma-nera*). The question, then, is whether such clarity of syllable boundary means that a syllabic analysis is optimal in reading Spanish. This is examined in Experiment 2.

Experiment 2

Method

Materials and procedure. Experiment 2 used that same word items as in Experiment 1 (except that the necessary diacritic was added to the *o* of words ending in *on*, such as *carbón*, *legión*). Many of the nonwords were also the same (e.g., *fapon*, *menitiar*), but several were made to look more like Spanish (e.g., *briño*, *lejuis*). Otherwise the experimental procedure was the same as in Experiment 1. The reading test was a direct Spanish translation of the English test.

Participants. The participants were 51 native Spanish speakers who were undergraduates and staff in psychology at the University of La Laguna. The students were given course credit for their participation.

Results and Discussion

The data from one participant was discarded owing to a higher than 30% error rate in one condition. Excessively long or short responses were treated in the same way as in Experiment 1.

The mean response time and error rate for the BOSS division condition was 758 ms and 3.4% respectively while for the syllable division it was 721 ms and 3.6% respectively. The reaction time advantage for the syllable condition proved to be significant, $F_1(1, 47) = 24.13$, $p < .001$; $F_2(1, 39) = 15.82$, $p < .001$), but there was no effect on errors (both Fs < 1). It can therefore be seen that, in contrast to English, a syllabic division appears to be more compatible with Spanish processing mechanisms than is a BOSS division. Nonetheless, a correlational analysis was carried out to determine whether reading ability in Spanish related to greater (or lesser) use of syllabic structure. Reading scores ranged from 4 through to 29 correct, with an average of 15.6. The BOSS preference score was determined in the same way as in English, so that syllable preference emerges as a negative score.

Perhaps surprisingly, the indications are that in Spanish, as in English, it is the poorer readers who appear to be more oriented toward the syllable than are the better readers despite the overall syllable bias for Spanish readers. In fact, the correlation was not significant, $r(51) = .173$, $p > .1$, but consultation of the scattergram shown in Figure 2 reveals one obvious outlier (a "good" reader with a very large syllable preference). If this single outlier were to be treated as an aberration and their data deleted from the analysis, the correlation becomes highly significant, $r(50) = .348$, $p < .02$.

In correspondence with the correlational data, analysis of a median split on the basis of reading scores (again split between 15 and 16 correct) revealed

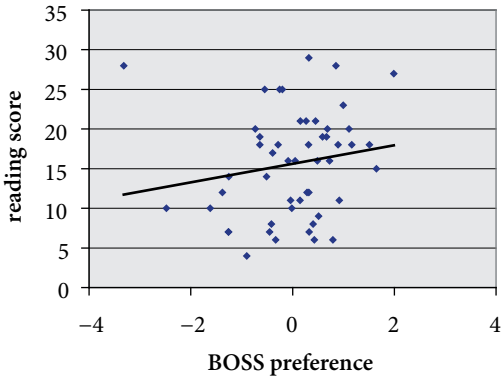

Figure 2. Scattergram for the correlation in Experiment 2 between reading comprehension performance (reading score) and BOSS preference for native Spanish readers.

Table 2. Mean lexical decision times (and error rates in parentheses) for the upper and lower Spanish reading groups in Experiment 2, as determined by a median split of reading comprehension scores.

	BOSS e.g., *cact us*	**Syllable** e.g., *cac tus*	**difference**
"Better" readers	738 ms (3.1%)	718 ms (4.0%)	−20
"Poorer" readers	771 ms (6.7%)	722 ms (4.9%)	−49

that the interaction between reading performance and divisional preference was only a trend when including the outlier, $F_1(1,47) = 3.94$, $p < .1$, $F_2(1,39) = 0.19$, $p > .1$, but significant in the participant analysis when not, $F_1(1,46) = 7.94$, $p < .01$, $F_2(1,39) = 2.06$, $p > .1$.[2] The means given in Table 2 include the outlier. None of the error analyses were significant, with all Fs < 1.04.

An analysis of the poorer readers shows a clear syllable preference, $F_1(1,21) = 24.13$, $p < .001$, $F_2(1,39) = 10.80$, $p < .01$, and the better readers also show such a preference, $F_1(1,26) = 4.31$, $p < .05$, $F_2(1,39) = 5.49$, $p < .05$, though this reduces to a trend when the outlier is removed, $F_1(1,25) = 3.97$, $p < .1$, $F_2(1,39) = 0.88$, $p > .1$. It is apparent, then, that reading in Spanish is different to reading in English in that better Spanish readers find a maximal onset division more compatible with their processing of visually presented words than a maximal coda analysis, whereas in English this is not the case. However, consistent with what was found in English, the poorer Spanish readers appear to show a greater syllabic orientation relative to a BOSS orientation than do the better readers.

General Discussion

The main difference between English and Spanish reading appears to arise largely from the better readers inasmuch as better Spanish readers are biased toward a maximal onset analysis while better English readers are biased toward a maximal coda analysis. Although reading ability was based on the same comprehension items in the two languages, it cannot be said that a particular score means exactly the same thing in each language. It is possible, for example, that by using a direct translation of the English comprehension test, the Spanish test may have been somewhat unnatural. However, the only concern about this for the present conclusions would be if it could be argued that the reason for the difference between better Spanish and English readers was because the reading level of the former was actually equivalent to the poorer English reading level, who also showed a syllable preference. Such an argument seems unreasonable, though, because the Spanish reading scores were actually higher than the English reading scores, regardless of whether the Spanish reading test was stilted or not. In other words, the better Spanish readers tended to show a syllable bias and the better English readers tended to show a BOSS bias despite the fact that the former were potentially more proficient at reading than the latter.

Having said this, however, it was nevertheless the case that the better Spanish readers appeared to show a weaker syllabic bias than the poorer Spanish readers (most notably if the single outlier is ignored). How can this be explained?

One possibility is that there are two routes to word recognition, one using orthographic information only and the other being mediated through phonology: The optimal orthographic route makes use of an analysis that maximizes the informativeness of the initial unit of the polysyllabic word (i.e., it maximizes the coda), while the phonological route is sensitive to syllable structure. In this way, a BOSS bias is generated from the orthographic route while a syllable bias arises from the phonological route. The latter is consistent with a study in Spanish that showed that a homophone of the first syllable of a word was as effective a prime of that word as was the syllable itself (Álvarez, Carreiras, & Perea, 2004).

It can then be suggested that both the orthographic and phonological routes are used in Spanish (see Álvarez et al., 2001, for such a suggestion as one way to handle the independent effects of syllable frequency and root frequency), but with a different weighting depending on reading proficiency. That is, the better the reader, the greater the use of the orthographic route and, therefore, the weaker the impact of syllabic structure. The same explanation can be given for English (see Taft 2001), although there is less impact of the phonological route because it is less readily available than in Spanish owing to the inconsistencies in mapping English orthography to phonology. Such an idea is equivalent to the Orthographic Depth

Hypothesis (e.g., Katz & Feldman, 1983; Katz & Frost, 1992) that proposes that the more transparent the relationship between graphemes and phonemes in a language, the more likely phonological mediation will be used in word recognition.

According to this account of the data, the BOSS is not only the optimal orthographic structure in English, but in Spanish as well. The difference between Spanish and English lies simply in the relatively more prominent use of the phonological route in Spanish such that a syllable orientation dominates. Note that Álvarez et al. (2001) found that BOSS frequency had no impact in Spanish (when both root frequency and syllable frequency were controlled) and this might be taken as a contradiction to the claim that the BOSS is at all relevant in Spanish. However, if phonological processing dominates in Spanish, then the impact of the BOSS will not be discernible because it arises within the orthographic route to recognition. What this means is that if BOSS and syllable frequency effects were examined in relation to reading proficiency, the prediction would be made that reading ability correlates negatively with syllable frequency, but positively with BOSS frequency.

There is, however, an alternative account of the Spanish data that challenges any involvement of the BOSS at all, hence being consistent with the failure to observe a BOSS frequency effect in Spanish (Álvarez et al., 2001). According to this account, better Spanish readers are actually more sensitive to the spoken syllable structure than are poorer Spanish readers. Rather than saying that the better readers are more BOSS oriented than the poorer readers, one could say that the former are simply more tolerant of non-syllabic disruptions. That is, a syllabically divided word (e.g., *cac tus*) is compatible with the lexical processing strategies of all Spanish readers, but better readers are less disturbed by the presentation of a word divided non-syllabically (e.g., *cact us*). It may be that better readers are so sensitive to syllabification that they can extract the appropriate syllabic structure from the incompatible BOSS-divided word more readily than can a poorer reader.

Indeed, physically providing the syllabification of a word (as in *cac tus*) may benefit the poorer reader to a relatively greater degree than the better reader because the latter is already able to syllabify undivided words very easily. Such a conclusion is compatible with the fact that the good and poor readers did not differ in their responses to syllable-divided words (only to BOSS-divided words). So, even though poorer readers might have been expected to have had longer lexical decision times than better readers, this was not so when the syllable structure was explicitly highlighted (e.g., *cac tus*). To examine this interpretation, it would be useful in future experiments to include a baseline condition where words are not divided at all, so that the relative impact of being physically provided with the appropriate syllabification can be determined.

So, there are two very different accounts of the Spanish data. By one account, better reading in both Spanish and English is associated with a greater involvement

of an orthographic system that maximizes the coda structure (compatible with the BOSS) relative to a phonological system that maximizes the onset structure (compatible with the syllable), but that the former is still dominated by the latter for Spanish readers. By the alternative account, better Spanish readers are more sensitive to syllabification than are poorer Spanish readers and thus can more readily overcome the syllabic disruption engendered by a BOSS division. If the latter is the correct interpretation, the distinction between Spanish lexical processing and English lexical processing is heightened because the same account cannot be applied to the English data. In particular, the interaction between BOSS preference and reading ability in English cannot be characterized in terms of a weaker disruption to standard syllabic processing for better readers when the word is divided according to the BOSS. This is because better readers showed no disruption at all in the BOSS condition, with any trend being in the opposite direction. That is, there is no sign at all that syllabic processing is standard for better English readers, unlike better Spanish readers.

Whichever of the two alternative accounts of the Spanish data is correct, they both entail that phonological influences are dominant in Spanish. This has been put down to the consistency that exists between the graphemes and phonemes of the language, that is, the fact that it has a shallow orthography. However, it could also be explained in terms of the related factor of the transparency of syllable structure. The contrast between orthographic depth and syllable transparency can be seen when considering the example of French. French has a clear syllable structure (e.g., Cutler et al., 1986; Mehler, Dommergues, Frauenfelder, & Segui, 1981), yet appears to be orthographically less shallow than Spanish. For example, *dix* and *prix* do not rhyme, and neither do *femme* and *gemme*, *mat* and *rat*, or *sens* and *gens*. In addition, the final consonant of a word might be silent or pronounced depending on the initial sound of the next word, which adds complexity to the idea of sublexical translation from orthography to phonology in French. Therefore, if orthographic depth is the factor that is most relevant in expediting the use of the phonological pathway, it would be expected that a syllable bias would be less observable in French than in Spanish.

Although Taft and Radeau (1995) provided evidence for the syllable as a unit of processing in French, their task involved overt naming. Using tasks that did not entail the use of phonological information (e.g., lexical decision), Rouibah and Taft (2001) actually found a strong bias toward the BOSS. This was the case despite the fact that there was no systematic selection of participants on the basis of reading proficiency. In other words, French readers showed an even stronger BOSS orientation than English readers, which was quite unexpected. It cannot be concluded, then, that the clarity of a language's syllable structure determines whether speakers of that language are sensitive to syllable structure in reading, since French

and Spanish are comparable in this regard. However, it also seems inappropriate to ascribe a bias against syllabic processing to the orthographic depth of the language, given that this bias appears greater in French than in English despite the latter being orthographically deeper. There clearly needs to be further exploration of the potential differences in orthographic processing between languages.

A final issue that needs to be raised is the fact that the BOSS contains more graphemic information than does the first syllable. That is, it could be argued that a BOSS preference arises merely from the advantage of having an extra letter in the first presented constituent of the stimulus (e.g., *cact* vs, *cac*), and it may be the case that better readers are simply more proficient in making use of this extra information. The counter-argument to the notion that the extra letter provides a potential advantage to the BOSS, draws upon previous studies that have shown that word recognition is not a function of the mere length of the first presented constituent. In particular, when the first constituent includes one more letter than the BOSS (i.e., the BOSS + 1, e.g., *cactu*), response times are no faster than when the first constituent is the BOSS (Taft, 1987, in English; Rouibah & Taft, 2001, in French). In fact, response times to the BOSS + 1 condition was shown to fall somewhere between the syllable and BOSS conditions in all experiments. Thus, it is clear that RTs do not decrease as a linear function of the number of letters in the first presented constituent.

Conclusion

This study looks at the influence of language on the use of internal orthographic structure in lexical processing, in particular, the involvement of a maximal onset strategy (reflected in a syllable preference) or a maximal coda strategy (reflected in a BOSS preference). Experiment 1 conforms with studies that have found that the preferred strategy in English depends on the level of reading proficiency, with better reading being associated with a greater bias toward a BOSS analysis (Taft, 2001, 2002). Experiment 2 reveals a different story for Spanish. While the same sort of correlation with reading proficiency was observed, even the better readers were biased toward a syllabic analysis. There are two interpretations that can be given to this result.

The first places emphasis on the similar correlation between divisional preference and reading ability that was observed in the two languages, and suggests that the preference shown depends on the relative importance of the orthographic and phonological routes, with a syllable preference arising when the latter dominates and a BOSS preference arising when the former dominates. Spanish readers simply have a relatively more dominant phonological route than do English readers,

though the better the reader in either language, the more influential the orthographic route.

The second account, on the other hand, places emphasis on the overall syllable preference observed in Spanish and suggests that all Spanish reading is characterized by phonologically based processing. Better readers are so syllabically biased that they are less distracted than poorer readers when the syllabic structure is obscured (as in the BOSS condition).

Further research is therefore required to differentiate these two very different accounts. What has been demonstrated here, though, is that the structure of the specific language being read has a clear impact on the lexical processing mechanisms adopted in that language, though the proficiency of the reader might modulate the nature of that impact.

Author note

This research was supported by a grant from the Australian Research Council awarded to Marcus Taft, as well as grants from the Spanish Ministry of Education and Science awarded to Carlos J. Álvarez (SEJ2004-03775), and Manuel Carreiras (BSO2003-01135 and SEJ2004-07680-CO2-02?PSIC). The assistance of Mark Sabaz and Louisa Carroll in conducting the English experiment is gratefully acknowledged.

Notes

1. In the post-hoc analyses of the English data, no item analyses are reported. The division into good and poor readers, each assigned to two sublists of items, led to a situation where each item mean was based on very few scores, typically 6 or less. Under such conditions, item RTs are meaningless.

2. The item analyses are reported for the Spanish data because the lowest number of participants contributing to any item mean was 10 which, while low, was considered of sufficient magnitude to be potentially meaningful.

References

Álvarez, C. J., Carreiras, M., & De Vega, M. (2000) Syllable frequency effect in visual word recognition: Evidence of a sequential-type processing. *Psicológica*, *21*, 341–374.

Álvarez, C. J., Carreiras, M., & Perea, M. (2004). Are syllables phonological units in visual word recognition? *Language and Cognitive Processes*, *19*, 427–452.

Álvarez, C. J., Carreiras, M., & Taft, M. (2001). Syllables and morphemes: Contrasting frequency effects in Spanish. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*, 545–555.

Bradley, D. C., Sánchez-Casas, R. M., & García-Albea, J. E. (1993). The status of the syllable in the perception of Spanish and English. *Language and Cognitive Processes*, *8*, 197–233.

Carreiras, M., Álvarez, C. J., & de Vega, M. (1993). Syllable frequency and visual word recognition in Spanish. *Journal of Memory and Language*, *32*, 766–780.

Cutler, A., Mehler, J., Norris, D. G., & Segui, J. (1986). The syllable's differing role in the segmentation of French and English. *Journal of Memory & Language*, *25*, 385–400.

Jared, D., Levy, B. A., & Rayner, K. (1999). The role of phonology in the activation of word meanings during reading: Evidence from proofreading and eye movements. *Journal of Experimental Psychology: General*, *128*, 219–264.

Katz, L., & Feldman, L. B. (1983). Relation between pronunciation and recognition of printed words in deep and shallow orthographies. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *9*, 157–166.

Katz, L., & Frost, R. (1992). The reading process is different for different orthographies. In R. Frost & L. Katz (Eds.) *Orthography, phonology, morphology, and meaning* (pp. 67–84). Amsterdam: North-Holland.

Lewellen, M. J., Goldinger, S. D., Pisoni, D. B., & Greene, B. G. (1993). Lexical familiarity and processing efficiency: Individual differences in naming, lexical decision, and categorization. *Journal of Experimental Psychology: General*, *122*, 316–330.

Mehler, J., Dommergues, J. Y., Frauenfelder, U., & Segui, J. (1981). The syllable's role in speech segmentation. *Journal of Verbal Learning and Verbal Behavior*, *20*, 298–305.

Perea, M. & Carreiras, M. (1998). Effects of syllable frequency and syllable neighborhood frequency in visual word recognition. *Journal of Experimental Psychology: Human Perception & Performance*, *24*, 134–144

Rouibah, A., & Taft, M. (2001). The functional role of syllabic structure in French visual word recognition: The BOSS hypothesis revisited. *Memory & Cognition*, *29*, 373–381.

Sánchez-Casas, R. M (1996). Lexical access in visual word recognition: The contribution of word form. In M. Carreiras, J.E. García-Albea, & N. Sebastián-Gallés (Eds.) *Language processing in Spanish* (pp. 21–59). New Jersey: Erlbaum.

Sebastián-Gallés, N., Dupoux, E., Segui, J., & Mehler, J. (1992). Contrasting syllabic effects in Catalan and Spanish. *Journal of Memory & Language*, *31*, 18–32.

Taft, M. (1979). Lexical access via an orthographic code: The Basic Orthographic Syllabic Structure (BOSS). *Journal of Verbal Learning and Verbal Behavior*, *18*, 21–39.

Taft, M. (1986). Lexical access codes in visual and auditory word recognition. *Language and Cognitive Processes*, *1*, 49–60.

Taft, M. (1987). Morphographic processing. The BOSS re-emerges. In M. Coltheart (Ed.), *Attention and performance*, *XII* (pp. 265–279). London: Lawrence Erlbaum Associates Limited.

Taft, M. (1992). The body of the BOSS: Subsyllabic units in the lexical processing of polysyllabic words. *Journal of Experimental Psychology: Human Perception and Performance*, *18*, 1004–1014.

Taft. M. (2001) Processing orthographic structure by adults of different reading ability. *Language & Speech*, *44*, 351–376.

Taft, M. (2002). Orthographic processing of polysyllabic words by native and non-native English speakers. *Brain and Language*, *44*, 351–376.

Taft, M., & Radeau, M. (1995). The influence of the phonological characteristics of a language on the functional units in reading: A study in French. *Canadian Journal of Experimental Psychology*, *49*, 330–346.

Author's address

Marcus Taft
School of Psychology
University of New South Wales
Sydney NSW 2052
Australia
Phone: 61-2-93853026
Fax: 61-3-93853641

M.Taft@unsw.edu.au

Appendix

The following are the words used in both experiments.

actor, *actual*, *agenda*, *bacteria*, *bravo*, *cactus*, *carbon*, *cartel*, *carton*, *central*, *cereal*, *circular*, *debate*, *disco*, *drama*, *factor*, *familiar*, *fatal*, *final*, *formal*, *funeral*, *fusion*, *habitual*, *ideal*, *iguana*, *lamentable*, *legion*, *limbo*, *mango*, *marina*, *memorial*, *municipal*, *particular*, *pastor*, *penal*, *pension*, *plaza*, *original*, *radio*, *sentimental*