Psychonomic Bulletin & Review
2006, 13 (2), 339-345

Associated or dissociated effects of syllable frequency in lexical decision and naming

MARKUS CONRAD, PRISCA STENNEKEN, and ARTHUR M. JACOBS
Freie Universität Berlin, Berlin, Germany

Most empirical work investigating the role of syllable frequency in visual word recognition has focused on the Spanish language, in which syllable frequency seems to produce a classic dissociation: inhibition in lexical decision tasks but facilitation in naming. In the present study, two experiments were run in German, using identical stimulus materials, in a lexical decision task and a naming task. In both tasks, there was an inhibitory effect for words with a high-frequency first syllable. This pattern of results, suggesting a stronger weight of lexical access in the naming process in German than in Spanish, is discussed with regard to the issue of stress assignment in the two languages and within the framework of word production models. Items, mean response latencies, and accuracy rates per item for both experiments can be downloaded from www.psychonomic.org/archive.

The finding of an inhibitory effect of first-syllable frequency has been the starting point for an intense debate in the field of visual word recognition. The question of whether syllables are automatically processed when polysyllabic words are read is of special interest, because if it proves to be the case, current computational models of visual word recognition that do not contain any syllabic representations will have to be revised (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Grainger & Jacobs, 1996; Zorzi, Houghton, & Butterworth, 1998).

For the Spanish language, the effect has been shown to be reliable in several studies reporting increased lexical decision latencies when the frequency of the first syllable in a disyllabic word is high. This inhibitory effect in a task usually requiring lexical access is accounted for in terms of a nonimplemented interactive activation model, in which competing word representations that are activated via the first syllable of a given target interfere with the processing of the target (Carreiras, Álvarez, & de Vega, 1993; Perea & Carreiras, 1998). Increasing syllable frequency would cause more interference, because a syllable that is shared by many words would activate more competing candidates in a hypothetical mental lexicon.

Recently, the inhibitory effect of syllable frequency on lexical access has been replicated in one other Romance language, French (Mathey & Zagar, 2002), and in German (Conrad & Jacobs, 2004), a non-Romance language.

However, the picture is less clear for the naming task: The only language for which an effect of first-syllable frequency in disyllabic words has been reported is Spanish. Perea and Carreiras (1998) showed that naming latencies are reduced when first-syllable frequency is high. This theoretically interesting dissociation of the syllable frequency effect in two different tasks was accounted for by Perea and Carreiras (1998) by assuming that when overt pronunciation is required, the locus of the effect would shift to motor output, whereby high-frequency syllables representing well-learned units of speech could be produced more rapidly. This argument is in line with the findings of Levelt and Wheeldon (1994), who obtained reduced naming latencies when the second syllable of a disyllabic word was of high frequency.

Thus, a dissociation of initial-syllable frequency effects between lexical decision and word-naming tasks can be said to exist for the Spanish language.

Are there reasons that the same would hold true for German? A facilitative effect of first-syllable frequency on naming latencies can only appear when: (1) The postulated facilitation of motor output is strong enough to override the inhibition due to syllable frequency that must have been effective when this word was lexically accessed (postlexical locus of effect), (2) Inhibition during lexical access becomes less relevant, because words can be named according to phonological regularities without necessarily being fully identified (nonlexical locus of effect), or (3) Despite lexical processing, at an early moment during the time course of word processing, the gestural stores of syllabic units are already activated by syllabic units (pre- and postlexical locus of effect).

In the experiment of Perea and Carreiras (1998) that documented a facilitative effect of syllable frequency in naming, a facilitative effect of word frequency was also obtained. This is interpreted by the authors as strong evidence for the involvement of lexical processes in the naming task in Spanish. They explain their empirical findings for the naming task—a facilitative effect for first-syllable frequency that is very robust for nonwords (Carreiras &

This research was supported by two grants to A.M.J. from the Deutsche Forschungsgemeinschaft (Ja 823/3-1/Jacobs "Zur Rolle phonologischer Prozesse beim Lesen komplexer Wörter: Ein sprachvergleichender Ansatz") and from the Deutscher Akademischer Austauschdienst (Acciones Integradas Hispano–Alemanas D/03/39324). Correspondence concerning this article should be addressed to M. Conrad, Allgemeine Psychologie, Freie Universität Berlin, Habelschwerdter Allee 45, 14195 Berlin, Germany (e-mail: markus_conrad@gmx.de).

Perea, 2004; Perea & Carreiras, 1996) and diminished but still significant for words (Perea & Carreiras, 1998)—as follows: Due to an ease of articulation at a late stage of word processing (the state of phonological output) high-frequency syllables are accessed and produced faster than low-frequency syllables and, in the case of naming bisyllabic words, this facilitation is slightly affected but not canceled out by the inhibitory effect of syllable frequency on lexical access (Perea & Carreiras, 1998).

The question of whether and to what extent processes related to lexical access influence the performance of subjects in a naming task is a crucial issue.

In theory, readers in shallow orthographies should be able to correctly pronounce any word without necessarily fully accessing it in the mental lexicon, using one-to-one translation of graphemes into phonemes. Perea and Carreiras (1998) interpret the presence of a word frequency effect in their naming experiment as evidence against such a nonlexical strategy. However, effects of word frequency in naming have also been reported for a delayed naming task by Balota and Chumbley (1985), who stated that "a large component of the frequency effect in the pronunciation tasks involves production rather than simple lexical access." It therefore still seems possible to attribute the facilitative effect of syllable frequency on naming latencies in the study of Perea and Carreiras (1998) to pre- or nonlexical processing.

In the model presented by Ferrand, Grainger, and Seguí (1994), articulatory output units can be activated directly by sublexical orthographic or phonological units without the orthographic or phonological lexicon necessarily being involved. We suppose that at a prelexical level, syllable frequency might affect performance in a naming task in Spanish and in German in a specific way, determined by a differential involvement of lexical processing during the naming task.

German is almost as consistent as Spanish with regard to the conversion of graphemes into phonemes, but when bisyllabic words have to be named, there is a reason why it is more difficult to do so correctly in German than in Spanish before a word has been lexically accessed: Any word containing several syllables is stressed in one specific position, and, when asked to pronounce it, a reader has to know exactly which syllable to stress. Thus, stress information is a necessary prerequisite of correct naming in any language. Now, if correct pronunciation is possible without lexical access in a given language, how could Spanish or German readers know how to stress a disyllabic word before they know what the word means?

To find out if there are statistical regularities of stress assignment in Spanish and in German that could help readers correctly infer the stress pattern of a disyllabic word at a prelexical processing level, we analyzed two databases: LEXESP (Sebastián, Martí, Carreiras, & Cuetos, 2000), for Spanish, and CELEX (Baayen, Piepenbrock, & van Rijn, 1993), for German. In both languages, penultimate stress is the most common pattern: 82% of all Spanish and 87% of all German disyllabic words have initial stress. However, the percentage of words that do not follow this pattern seems high enough to assume that stress assignment in both languages is not unambiguous.

There is an interesting pattern that perfectly reduces this ambiguity in Spanish, but not in German: In Spanish, orthographic accents are used to mark irregular stress. (For the use of orthographic accents, see Real Academia Española, 1982.) For all Spanish words[1] without orthographic accent, statistically, there is one feature that predicts the word's stress pattern with a reliability of almost 100%: the word's last letter. A specific letter can either appear at the end of a word with penultimate stress or at the end of a word with ultimate stress, but never at the end of both types of words. In addition, both for words with penultimate stress and words with ultimate stress, in more than 99% of the relevant cases, there are only four letters with which they can end. More than 99% of all Spanish words with ultimate stress and no orthographic accent end with one of these letters: "r," "l," "d," or "z." In contrast, all Spanish words with penultimate stress and no orthographic accent end with one of these letters: "a," "o," "s," or "e."

None of this holds true for German. There are no orthographic accents in German. Neither can the stress pattern of a bisyllabic German word be predicted by the identity of its last letter: German words with ultimate stress can end with 25 different letters; those with penultimate stress can end with 23 different letters.

Given this simple account of the variance of stress patterns in Spanish, we assume that Spanish readers are able to reliably infer the stress pattern of a disyllabic word after a superficial, prelexical analysis: screening for orthographic accents and final letters. The same would not hold true for German readers. Thus, Spanish but not German readers could correctly pronounce any word of their orthography without necessarily fully accessing their mental lexicon. In German this would be possible to a lesser degree, because one aspect of phonological information that is crucial for the selection of the appropriate articulatory motor program would not be available before lexical access is achieved: the word's stress pattern.

The aim of the present study is to clarify how initial-syllable frequency is influential in the naming task in German, in which stress patterns are more ambiguous than in Spanish. If early prelexical processing is responsible for the facilitative effect of initial-syllable frequency in the naming task in Spanish, then the same effect is not likely to appear in German. If, in German, full lexical access is necessary for obtaining the stress pattern of a disyllabic word, a facilitative effect of syllable frequency on naming latencies, as documented by Perea and Carreiras (1998), should be affected greatly by the inhibitory effect of syllable frequency on lexical access documented for lexical decision.

If the locus of the effect is only to be seen at a late stage of processing, whereby phonological output is produced after a word has been lexically accessed and its whole phonological word form is available, then the same effect of syllable frequency in the naming task (as in Spanish) should be observed in German. However, it is unclear whether facilitation of motor output that arises only when the complete phonological word form has become available is sufficient to produce facilitation for words with high-frequency initial syllables in the naming task, given that these words had already been the object of inhibitory processes related to lexical access.

For nonwords, a different pattern of results can be expected: Nonwords are not supposed to have an entry in the mental lexicon, and thus, no lexical access will occur. For German nonwords, stress assignment could easily be achieved using the global stress pattern of the German language as a default principle. 87% of bisyllabic German words have initial stress. Only a word's meaning—no superficial prelexical features—determines differing ultimate stress. When asked to pronounce a German nonword that has no meaning, participants can always do so stressing the first syllable, following this default principle of German stress. The assumed facilitation for high-frequency syllabic units at the level of motor output should lead to speeded naming latencies for nonwords with high-frequency initial syllables. In the lexical decision task, syllable frequency should cause inhibition for nonwords as well as for words, because a high-frequency initial syllable would open a wider search space for any possible lexical candidate activating the representations of words sharing the nonword's first syllable (Conrad & Jacobs, 2004).

EXPERIMENT 1
Lexical Decision

Before one investigates the effects of syllable frequency on naming latencies, it should be clear to what extent the difficulty of lexical access varies within the given stimulus material. We examined this using a lexical decision task.

Method

Participants. Twenty-eight students from the Catholic University of Eichstätt–Ingolstadt participated in the experiment.

Design and Stimuli. We selected 112 disyllabic German words of five and six letters in length from the CELEX database (Baayen et al., 1993) according to the orthogonal combination of two factors in a within-participants 2 × 2 design: word frequency and positional frequency of the first syllable. Words were matched across the experimental conditions for initial phoneme, length, and number of phonemes. None of the words had orthographic neighbors of higher word frequency. In addition, words belonging to the conditions that differed in syllable frequency but not in word frequency were also matched for number of orthographic neighbors and positional frequency of the second syllable. We constructed 112 nonwords combining first and second syllables of real words. Controlling for initial phoneme, orthographic neighborhood density, the positional frequency of the second syllable, and length, nonwords were organized in two groups, according to the manipulation of the factor first-syllable frequency (high vs. low). Stimuli were presented in uppercase letters using Courier 24-point type. Characteristics for the stimuli are shown in Table 1.

Apparatus and Procedure. Each trial was initiated by a fixation point appearing at the center of the computer screen for 500 msec. The fixation point was then replaced by the word or nonword stimulus that remained visible until the participants pressed a button indicating their decision concerning the lexicality of the stimulus ("yes" button for a word; "no" button for a nonword). No error feedback was given. Stimuli appeared in randomized order for each participant. There were 10 initial training trials.

Table 1
Characteristics of Words and Nonwords Used in Experiments 1 and 2

	WF		Log WF∗10		SF1		Log SF1∗10		SF2		Log SF2∗10		N		L		Ph	
	M	Range	*M*	Range	*M*	Range	*M*	Range	*M*	Range	*M*	Range	*M*	Range	*M*	Range	*M*	Range
Word Class																		
High WF/High SF	633	101–9,923	2.37	2.00–4.00	7,445	1,712–16,450	3.73	3.23–4.22	2,990	108–16,350	3.01	2.03–4.21	2.00	0–7	5.64	5–6	5.14	4–6
High WF/Low SF	204	108–750	2.27	2.03–2.68	364	125–633	2.53	2.10–2.80	3,858	131–14,485	3.26	2.12–4.16	2.89	0–8	5.64	5–6	5.25	4–6
Low WF/High SF	4.26	0.67–9.17	0.53	−0.17–0.96	15,136	1,677–110,013	3.84	3.22–5.04	215	2–1,279	1.79	0.30–3.11	0.71	0–3	5.64	5–6	5.29	4–6
Low WF/Low SF	3.92	0.50–9.00	0.48	−0.30–0.95	108	1–614	1.52	−0.08–2.78	364	3–1,406	2.12	0.40–3.15	0.75	0–4	5.68	5–6	5.25	4–6
Nonword Class																		
High SF					9,901	1,712–110,013	3.77	3.23–5.04	224	0.17–1,435	0.12	−0.78–3.16	0.32	0–6	5.36	5–6		
Low SF					112	0.17–786	1.10	−0.78–2.90	207	0.17–1,435	0.28	−0.78–3.16	0.21	0–3	5.48	5–6		

Note—The left half of the table shows the means (*M*) and ranges of the independent variables word frequency (WF) and frequency of the first syllable (SF1). The right half of the table shows the means and ranges of variables that were held constant: frequency of the second syllable (SF2), density of the orthographic neighborhood (N), stimulus length (L), and number of phonemes (Ph). WF, frequency of occurrence per 1 million words; SF, calculated as cumulative frequency of all words sharing a given syllable in an identical position.

Results and Discussion

Words. Mean correct response latencies and error percentages (see Table 2) were submitted to separate ANOVAs by participants and by items (F_1 and F_2, respectively). With regard to response times, the analyses revealed significant main effects of both word frequency and syllable frequency. High-frequency words were responded to 71 msec faster than were low-frequency words [$F_1(1,27) = 133.09$, $p < .0001$; $F_2(1,108) = 61.25$, $p < .0001$], whereas the frequency of a word's first syllable caused a delay of 17 msec in the latencies [$F_1(1,27) = 18.88$, $p < .0003$; $F_2(1,108) = 5.66$, $p < .01$]. There was no interaction between the two factors [$F_1(1,27) = 0.69$, $p > .4$; $F_2(1,108) = 0.86$, $p > .3$].

The error data mirrored this pattern of results, showing a facilitative effect of word frequency, with 2.2% errors for high-frequency words versus 8.7% for low-frequency words [$F_1(1,27) = 48.13$, $p < .0001$; $F_2(1,108) = 15.76$, $p < .0001$] and an inhibitory effect of syllable frequency, with 7.7% errors versus 3.2% for high versus low syllable frequency, respectively [$F_1(1,27) = 36.63$, $p < .0001$; $F_2(1,108) = 7.42$, $p < .007$]. The interaction between the two factors reached statistical significance in the analysis over participants, with high syllable frequency provoking more errors in low-frequency words than in high-frequency words [$F_1(1,27) = 16.49$, $p < .0003$; $F_2(1,108) = 2.19$, $p > .1$].

Nonwords. Correct rejections of nonwords with high first-syllable frequency were 38 msec slower than when the first syllable was low-frequent [$F_1(1,27) = 30.59$, $p < .0001$; $F_2(1,110) = 19.23$, $p < .0001$]. Similarly, high first-syllable frequency in nonwords provoked more errors than low first-syllable frequency (4.4% vs. 1.8%) [$F_1(1,27) = 15.43$, $p < .0004$; $F_2(1,110) = 5.84$, $p < .01$].

The significant inhibitory effects of initial-syllable frequency for words and for nonwords in the lexical decision task are in line with previous research in German (Conrad & Jacobs, 2004).

EXPERIMENT 2
Naming

After establishing that, with the selected stimulus material, the standard inhibitory effect of syllable frequency in lexical decision could be obtained, we used the same stimuli for a naming task. The aim of Experiment 2 was to examine whether initial-syllable frequency would produce any effect on naming latencies in German and whether such an effect would be associated or dissociated with the effect in lexical decision.

Method

Thirty-four students from the Catholic University of Eichstätt–Ingolstadt participated in the experiment. The stimuli, design, and procedure were the same as those used in Experiment 1, but this time, the task consisted of naming a presented stimulus. Mispronunciations and voice-key errors were coded offline, from tapes.

Results and Discussion

Words. There were significant main effects of both word frequency and syllable frequency. High-frequency words were named 28 msec faster than low-frequency words [$F_1(1,33) = 37.39$, $p < .0001$; $F_2(1,108) = 29.11$, $p < .0001$]. But, more important, initial-syllable frequency caused a delay of 11 msec on naming latencies. Words with high initial-syllable frequency were named more slowly than words with low initial-syllable frequency [$F_1(1,33) = 24.56$, $p < .0001$; $F_2(1,108) = 4.56$, $p < .03$] (see Table 3). There was no interaction between the two factors [$F_1(1,33) = 1.26$, $p > .2$; $F_2(1,108) = 0.33$, $p > .5$]. There were no effects on mispronunciation rates.

Nonwords. Nonwords with a high-frequency first syllable were named 18 msec faster than nonwords starting with a low-frequency syllable [$F_1(1,33) = 33.97$, $p < .0001$; $F_2(1,110) = 6.97$, $p < .01$]. Additionally, fewer mispronunciations occurred when nonwords with a high-frequency first syllable had to be named (7.5% vs. 10.8%) [$F_1(1,33) = 9.25$, $p < .004$; $F_2(1,110) = 4.96$, $p < .03$].

Importantly, Experiment 2 shows for the first time that syllable frequency affects naming latencies in German. The results of Experiment 2 also show an interesting pattern: the dissociation of the effects of syllable frequency for nonwords and words. We found a facilitative effect of syllable frequency for nonwords, as predicted by the assumption that phonological output is organized syllabically, with faster access to high-frequency units. Interestingly, this does not hold true when the given stimulus is a real word. For words, the results were comparable with those of Experiment 1, in which syllable frequency led to prolonged latencies in lexical decision.

Reanalysis of Experiments 1 and 2

The fact that orthographic neighborhood and second-syllable frequency had been closely controlled for in the stimulus material with regard to the factor first-syllable frequency but not the factor word frequency motivated multiple regression analyses of the data of both experi-

Table 2
Mean Reaction Times (RTs, in Milliseconds, With Standard Deviations) and Percentages of Errors for Words and Nonwords in Experiment 1

	Word Frequency								
	High			Low			Nonwords		
Syllable Frequency	RT	*SD*	% Error	RT	*SD*	% Error	RT	*SD*	% Error
High	581	76	3.2	656	101	12.1	664	108	4.4
Low	567	79	1.1	635	87	5.2	626	82	1.8

Table 3
Mean Latencies of Naming Onset (ON, in Milliseconds, With Standard Deviations) and Percentages of Mispronunciations for Words and Nonwords in Experiment 2

	Word Frequency								
First Syllable	High			Low			Nonwords		
Frequency	ON	*SD*	% Error	ON	*SD*	% Error	ON	*SD*	% Error
High	549	80	4.2	579	101	3.9	601	109	7.5
Low	540	75	2.6	565	90	4.0	619	114	10.8

ments using all manipulated and control variables as predictors of response latencies (see Table 4). Analyses revealed no significant effects for any of the control variables. In contrast, the log of word frequency significantly predicted response latencies in a facilitative way in lexical decision [$F(1,105) = 40.32$, $p < .0001$] and in naming [$F(1,105) = 12.22$, $p < .0008$]. Significant inhibition was the result for the log of first-syllable frequency in lexical decision [$F(1,105) = 10.64$, $p < .002$] and in naming [$F(1,105) = 5.48$, $p < .02$]. Thus, the outcome of both experiments was confirmed in the regression analyses.

GENERAL DISCUSSION

The present study provides evidence that effects of syllable frequency can depend on the specific structure of different languages. We have again shown that German readers apparently rely on the syllabic structure of words.

But with regard to the naming task, the effect of first-syllable frequency is contrary to what is reported for Spanish: German words are named more slowly when their first syllable is of high frequency. This finding does not contradict the proposal that phonological output is organized by syllabic units (Ferrand, Seguí, & Grainger, 1996) and that a syllable's frequency facilitates motor output (Levelt & Wheeldon, 1994). The facilitative effect of first-syllable frequency for nonwords in Experiment 2 replicates the findings of Carreiras and Perea (2004). Only when words are presented and lexical access becomes involved does this facilitation disappear.

In order to account for this intriguing finding, we propose a simple hypothesis emphasizing one aspect of the process of naming polysyllabic words: the consistency or inconsistency of stress assignment. Before a disyllabic word can be pronounced correctly, the reader has to know which syllable receives stress. Phonological output effects, the direction (facilitative or inhibitory) of which is the opposite of what is observed for lexical access, depend greatly on the involvement of lexical access in the given task. Even if one assumes that lexical processing is involved in the naming task in Spanish (Perea & Carreiras, 1998; but see Balota & Chumbley, 1985), the fact remains that it is possible to correctly pronounce a Spanish word without necessarily having lexical access to it before. Therefore, in Spanish, in which stress pattern can be inferred via superficial orthographic analyses, syllabic units can activate their corresponding motor programs at an early level of word processing, before lexical access has occurred, which leads to faster motor output for words with high initial-syllable frequency.

In German, this prelexical facilitation of motor output via syllabic units is not possible, because only when lexical access is achieved does the complete phonological information regarding a word's syllables, including the crucial information about whether a syllable has to be stressed, become available. The importance of processes related to lexical access in the naming task in German explains the inhibitory effect of syllable frequency for words in both experiments.

Taken together, the data for words and nonwords make it possible to draw new conclusions about the locus of the syllable-frequency effect in naming: Our nonword data indicate that the facilitation of mere motor output processes due to syllable frequency is the same in German as in Spanish. This would mean that at late stages of word processing, when lexical access has already occurred, phonological output in both languages should be influenced by

Table 4
Pearson Product–Moment (*r*) and Partial Correlations (*pr*) Between Response Latencies and Six Predictors in Experiments 1 (Lexical Decision) and 2 (Naming)

	Lexical Decision		Naming	
Predictor	*r*	*pr*	*r*	*pr*
Log word frequency	−.635	−.653*	−.457	−.416*
Log first syllable frequency	.106	.255*	.110	.212*
Log second syllable frequency	−.510	−.082	−.411	−.099
Number of orthographic neighbors	−.348	.016	−.321	−.058
Number of letters	.049	.052	.175	.191
Number of phonemes	.090	−.008	.130	−.042

*$p < .05$.

syllable frequency in the same way. Thus, the differential effects of syllable frequency in word naming for Spanish and German can only be explained by assuming that, at an early stage of word processing, syllable frequency influences the preparation of motor output in each language in a different way. The model of Levelt and Wheeldon (1994) could not account for this facilitation of motor output arising at a prelexical level, because the gestural stores of syllabic units in this model can only be accessed when the whole phonological word form is available. Therefore, this model predicts facilitative effects in word naming for second- but not for first-syllable frequency. In this model, syllables are accessed successively from the syllabary after the whole phonological word form is available, and a possible advantage for retrieving a high-frequency first syllable would already have decayed by the time the second syllable was accessed and pronunciation occurred. In fact, Levelt and Wheeldon obtained effects in the word naming task only for second-syllable frequency, not first-syllable frequency. In contrast, the finding of reduced naming latencies for words with high-frequency initial syllables fits well with the model proposed by Ferrand et al. (1994). In their model, motor output is thought to be prepared not only via the phonological lexicon, but also directly via the sublexical input. Note that the model of Ferrand et al. (1994) has been formulated using empirical results from a Romance language (French), whereas the Levelt and Wheeldon model relates to Germanic languages (Dutch and English). Typically, these two groups of languages differ in their degree of stress ambiguity. In French, stress assignment is regular; words always have ultimate stress. For Spanish, we have shown how stress information for a bisyllabic word can be obtained by a superficial orthographic analysis. In English, there is lexical stress that depends to some degree on the morphological structure of words. Readers of German words might need full lexical access before they could completely resolve uncertainty about the words' stress pattern. We suggest that facilitative effects of initial-syllable frequency are more likely to be obtained in Romance languages, because of their high degree of stress consistency.

An important issue for future research is the question of whether orthographic or phonological syllables are responsible for the segmentation of polysyllabic words. This question cannot be answered by the present study, because the high spelling-to-sound consistency in German does not allow attributing the empirical effects to either of them exclusively (see Álvarez, Carreiras, & Perea, 2004, and Stenneken, Conrad, Hutzler, Braun, & Jacobs, 2005, for different views on this issue).

In sum, we think that the proposal of stress ambiguity as a factor responsible for differential effects of syllable frequency in naming across different languages might motivate interesting cross-language research. The specific pattern of stress assignment in different languages is a crucial issue that models of word production would have to consider.

REFERENCES

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

Baayen, R. H., Piepenbrock, R., & van Rijn, H. (1993). *The CELEX lexical database* (CD-ROM). Philadelphia: Linguistic Data Consortium, University of Pennsylvania.

Balota, D. A., & Chumbley, J. I. (1985). The locus of word-frequency effects in the pronunciation task: Lexical access and/or production? *Journal of Memory & Language*, **24**, 89-106.

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

Carreiras, M., & Perea, M. (2004). Naming pseudowords in Spanish: Effects of syllable frequency. *Brain & Language*, **90**, 393-400.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review*, **108**, 204-256.

Conrad, M., & Jacobs, A. M. (2004). Replicating syllable frequency effects in Spanish in German: One more challenge to computational models of visual word recognition. *Language & Cognitive Processes*, **19**, 369-390.

Ferrand, L., Grainger, J., & Seguí, J. (1994). A study of masked form priming in picture and word naming. *Memory & Cognition*, **22**, 431-441.

Ferrand, L., Seguí, J., & Grainger, J. (1996). Masked priming of word and picture naming: The role of syllabic units. *Journal of Memory & Language*, **35**, 708-723.

Grainger, J., & Jacobs, A. M. (1996). Orthographic processing in visual word recognition: A multiple read-out model. *Psychological Review*, **103**, 518-565.

Levelt, W. J. M., & Wheeldon, L. (1994). Do speakers have access to a mental syllabary? *Cognition*, **50**, 239-269.

Mathey, S., & Zagar, D. (2002). Similarity in visual word recognition: The effect of syllabic neighborhood in French. *Current Psychology Letters: Behaviour, Brain & Cognition*, **8**, 107-121.

Perea, M., & Carreiras, M. (1996). Efectos de frecuencia silábica y vecindad ortográfica en la pronunciación de palabras y pseudopalabras. *Psicológica*, **17**, 425-440.

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.

Real Academia Española (Comisión de Gramática) (1982). *Esbozo de una nueva gramática de la lengua española*. Madrid: Espasa-Calpe.

Sebastián, N., Martí, M. A., Carreiras, M. F., & Cuetos, F. (2000). *LEXESP: Léxico informatizado del español*. Barcelona: Edicións de la Universitat de Barcelona.

Stenneken, P., Conrad, M., Hutzler, F., Braun, M., & Jacobs, A. M. (2005). Frequency effects with visual words and syllables in a dyslexic reader. *Behavioral Neurology*, **16**, 103-117.

Zorzi, M., Houghton, G., & Butterworth, B. (1998). Two routes or one in reading aloud? A connectionist dual-process model. *Journal of Experimental Psychology: Human Perception & Performance*, **24**, 1131-1161.

NOTE

1. Words like "sandwich" that are included in the database (Sebastián et al., 2000) but are not original Spanish words (but words from other languages) were excluded from this analysis.

ARCHIVED MATERIALS

The following materials associated with this article may be accessed through the Psychonomic Society's Norms, Stimuli, and Data archive, www.psychonomic.org/archive.

To access these files, search the archive for this article using the journal name (*Psychonomic Bulletin & Review*), the first author's name (Conrad), and the publication year (2006).

File: Conrad-PB&R-2006.zip

Description: The compressed archive file contains two files:

items.xls, containing items, mean response latencies, and accuracy rates per item for both experiments, as a 31K Excel worksheet generated by Excel 5.0 for PC.

items.txt, containing the same materials, as a 6K tab-delimited text file generated by Excel 5.0 for PC.

(Manuscript received October 13, 2004;
revision accepted for publication July 10, 2005.)