

Word Classes in Studies of Phonological Variation: Conditioning Factors or Epiphenomena?

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1. Introduction

Typological studies have demonstrated that all languages possess different parts of speech and, for instance, cross-linguistically all languages distinguish nouns from verbs. In fact, so pervasive is this linguistic truth, that, as noted by Vigliocco, Vinson, Druks, Barber, & Cappa (2011), it is widely maintained that grammatical category is itself cognitively separable from other types of linguistic information. Indeed, grammatical class has been argued to be a type of linguistic information independent of other pragmatic or semantic features and to be an active, organizing principle of the lexicon. Traditional models of speech production (e.g.; Levelt 1989) suggest fundamental cognitive processing differences required in the production of different word classes such as function and content words, and such processing differences may, thus, in turn affect production (Jurafsky, Bell, & Girand 2002, Phillips 2006, Gahl 2008). Precisely what the mechanisms underlying the production of word classes are, or how they operate upon phonological form, however, has not been entirely established.

In line with this view, studies of phonological variation and change include word or grammatical class as an independent linguistic variable thought to constrain variation. Significant word class effects have been noted in a wide range of studies (e.g.; Labov 2001). Often it is found that rates of reduction for a specific linguistic variable under investigation correlate significantly with different grammatical classes of words, and this is true both diachronically (e.g.; Phillips 2006) and synchronically (e.g.; Jurafsky, Bell, Gregory & Raymond 2001, Clark & Trousdale 2009). In Spanish, word class effects have been noted in studies on a multitude of phonological variables such as word-final /n/ velarization (Hoffman 2010), word-final /s/ realizations (Brown & Torres Cacoullós 2003, Valentín-Márquez 2006, Poplack 1980), intervocalic /d/ weakening (Moya Corral & García Wiedemann 2009), and hiatus resolution (Alba 2008), to name just a few.

Clearly, word classes matter. However, despite its frequent use as a factor in linguistic analyses, few attempts are made to explicitly state by what mechanism a word class can *actively* constrain variation. Indeed, the focus of this current paper will be to question whether, in fact, such a mechanism operates, and, alternatively, whether word class effects can be characterized as secondary symptoms of unidentified correlations in the data with variables known to promote reduction. Such correlations are known to exist for other linguistic predictors of reduction such as word frequency, but have not been studied for word classes.

The assertion that word class effects may be merely epiphenomenal is in line with viewing grammar as emergent (Bybee 2010). Word class distinctions, such as the difference between a noun and a verb, can be argued to arise in language as a result of differential semantic and pragmatic uses. Lexical representations of words (Bybee 2001), thus, are not independent of grammatical information and no categorically distinct representations or processes are presumed for separate word classes. Word class identity can be seen as indistinguishable from the significantly different patterns of use that naturally arise in discourse for words from different classes (Bybee 2002). Indeed, it is precisely such

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different discourse patterns, or “probabilistic distributional cues”, that enable classification of words into grammatical classes (Vigliocco et. al. 2011:422). What are these distributional cues and how do they implicate phonological variation?

If word class categories themselves are emergent and not stored lexically in any specialized way and not demanding of differential processing systems (Vigliocco et. al. 2011:422), it follows that the word class effects noted in studies of phonological variation may also be symptomatic of usage patterns. An explanation, thus, for significant correlations in data between word classes and rates of reduction may be found in usage patterns. Raymond, Dautricort, & Hume (2006:64) have already suggested that because word classes may differ with regard to their segmental and metrical phonology, “interactions with phonological variables are likely”. Such interactions may likewise include cumulative exposure to phonetic contexts of use.

This study will explore the determinative role attributed to word classes in constraining phonological variation and change. Through quantitative analyses of two linguistic variables (word-initial /s/ reduction, word-initial f- reduction) in spoken and written corpora of Spanish, this current project will show that significant interactions of word classes and phonological variables do, indeed, exist. Further, cumulative effects of online articulatory influences stemming from correlated phonological variables contribute to the appearance of word class effects. The organization of this work is as follows. First, section 2 identifies and describes the type of correlation proposed to account for word class effects (labeled *FFC*, or *Frequency in a Favorable Context* in this work). Section 3 presents the data and methods followed in this analysis. The results of quantitative analyses of the phonological variables in Spanish are presented in 4, and section 5 presents summary and conclusions.

2. FFC – Frequency in a Favorable Context (for reduction)

Studies that consider phonological variables almost universally identify and describe the specific effects of lexical and/or extralexical phonetic context on the variable under investigation. This follows from our understanding that the online effects of neighboring phones or phone classes on the articulation of sounds are significant. Specific phonetic contexts found in running discourse thus help promote variable realizations of words by alternately providing contexts both conducive and not conducive to reduction. The frequency with which words are used in running discourse in such favorable or unfavorable phonetic contexts varies considerably (Bybee 2001:142, 2002:277). Some words, in naturally occurring discourse, frequently occur in contexts favoring reduction, while others appear more frequently in contexts unfavorable to reduction. A word used frequently in a discourse context conducive to reduction, logically will have more opportunity to reduce. What’s more, the phonetic outputs, that are the natural by-product of these usage patterns, are captured and stored in phonological representations (Bybee 2001).

With these linguistic presuppositions [(i) phonetic context matters, (ii) experience in perception and production is registered in memory, (iii) words differ significantly in the frequency of occurrence in reducing vs. non-reducing environments], Bybee (2002) proposes the hypothesis regarding the role of discourse context frequency (deemed *FFC* in this work) in variable reductive processes. Since phonological context can affect the phonetic shape of the word, and, phonetic variation becomes registered in memory, Bybee (2002) argues that context of use is crucial to studies of phonological variation and change. Specifically, in the analysis of word-final -t/d deletion in American English, she finds that deletion rates for -t/d words correspond to their frequency of use in (un)favorable contexts and states that, “words that more frequently occur in the context favoring a change undergo the change at a faster rate than those that occur less frequently in the appropriate context” (276). She proposes that the cumulative experience that speakers have with words, not only directly reflects discourse patterns, but also shapes phonetic form.

Methodologically, *FFC* is a measure of cumulative exposure to reducing environments. What constitutes a reducing environment will depend upon the variable under study. By way of illustration, the following presents the case of variable deletion of word-initial /d/ in Puerto Rican Spanish. Spanish has two primary allophones of /d/; the voiced, dental stop [d], and the voiced, dental approximant or fricative [ð] (Barrutia & Schwegler, 1994: 114-120). The realizations and allophonic distribution of /d/ exhibit extensive regional variability (Amastae, 1989:170), and articulations of /d/ vary considerably

ranging from “a complete stop to a vocalic glide” (Cole, Hualde, & Iskarous, 1999:2). The voiced, dental stop [d] is prescriptively preferred in a post-pause, post-nasal, or post-/l/ (voiced, lateral, alveolar) context. The second principle allophone [ð] is realized in all post-vocalic contexts and post-consonantal contexts not described for [d]. Words vary, it turns out, as to the frequency with which they are used in the non-reducing (#, /l/, /n/, /m/ ____) and the reducing environments.

A comparison of the noun *doctor* ‘doctor’ and the verb *decir* ‘to say/tell’ illustrates this point. In the oral section of Davies (2002-), each word is used in contexts prescribing both allophones ([d], [ð]). Examples listed in (1a), taken from Davies (2002-) are tokens of *doctor* used in contexts favorable to reduction of word-initial /d/, and examples listed in (1b) are uses of *doctor* in contexts unfavorable to reduction. Similarly, tokens of *decir* are used in contexts favorable to reduction (2a) and unfavorable to reduction (2b).

- 1a. *Doctor*: Favorable context (N = 87), Davies (2002-)
 hablando de Doctor Zhivago, [*Habla Culta San Juan*]
 que había ganado este doctor [*Habla culta Buenos Aires*]
 una mujer que sea doctor [*Habla Culta México*]
 en los jóvenes, ¿verdad doctor? [*España Oral*]
- 1b. *Doctor*: Unfavorable context (N = 580), Davies (2002-)
 pensaba yo en el doctor Siddiqi, [*Entrevista ABC*]
 Ya debe ser un doctor, [*Habla Culta Bogotá*]
 Don X. se molesta si le dicen doctor; [*Habla Culta Bogotá*]
 Vamos a hablar con Doctor Javier [*España Oral*]
 Pues muy bien, Doctor Borregón, [*España Oral*]
- 2a. *Decir*: Favorable context (N = 7361), Davies (2002-)
 hay que aprender a decir que no [*Entrevista ABC*]
 ¿Qué quiere decir eso? [*Habla Culta Bogotá*]
 Sí, eso lo puedo decir [*Habla Culta Bogotá*]
 Sí, es decir, normalmente me gusta [*España Oral*]
 digamos, por decir algo, la existencia [*España Oral*]
- 2b. *Decir*: Unfavorable context (N = 74), Davies (2002-)
 pues no pueden decir eso [*Habla Culta Bogotá*]
 y sin decir de dónde [*Entrevista PRI*]
 entonces al decir algo [*Habla Culta México*]
.Decir que no tienen... [*Habla culta Buenos Aires*]

The FFC measure can be determined from the proportion of instances of use for each token in contexts favoring reduction; or each word’s frequency in a favorable environment. As can be seen in examples (1) and (2), the FFC measure is not dependent upon specific lexical items or specific phones but rather reducing environments generally. Table 1 summarizes the FFC values for each lexical item.

The noun *doctor* is rarely used (13%) in contexts that favor the approximant allophone ([ð]). Conversely, the lexical item *decir* is almost never found in a post-pause, post /l/, or post-nasal context, giving it an FFC measure of 99%. In almost every instance of its use, the phonological context in which *decir* is uttered predicts the approximant ([ð]) rather than the stop ([d]) articulation. FFC measures the cumulative effect on the lexical representation of repeated utterances in such contexts.

Table 1: FFC value for word-initial /d/ environments (Davies 2002-)

	Word Frequency	N in Favorable Environment (not post-pause, post-lateral, post-nasal)	FFC
<i>Doctor</i>	667	87	13
<i>Decir</i>	7435	7361	99

Averaged across the word class, nouns have a lower FFC (62) than verbs (84), as can be observed in Table 2. In other words, nouns are used more often in a post-pause, post-lateral, or post-nasal position than verbs. Given the terminal phoneme of the definite and indefinite articles (*el* and *un* respectively) this is easily understood; articles logically are more frequent with nouns than nominalized infinitives (i.e.; *el doctor*, *un doctor* vs. *el decir*). This usage pattern can give rise to the word class effects noted in studies of phonological variation; not because word class constrains variation, but rather due to its high correlation with usage patterns.

Table 2: Puerto Rican initial /d/ deletion in intervocalic contexts

Word Class	% Deletion	FFC
noun	7	62
preposition	9	72
adverb	11	74
adjective	17	79
verb	20	84
Total	14	77

Data adapted from Brown (2009)

Rates of deletion correlate with word classes as can be seen in the first two columns of Table 2. But rates of deletion (and word classes) also correlate with FFC. This type of correlation with ‘independent’ factor groups is not unheard of. For instance, the degree of collinearity between word frequency and factors such as word length, predictabilities from neighboring words and phones, neighborhood density, and speech rate is widely recognized and controlled in quantitative analyses (e.g.; Raymond et. al. 2006, Gahl 2008, File-Muriel & Brown 2011). This study suggests that the seldom examined independent linguistic variable (FFC) can account for word class effects. Indeed, word class effects are reporting in a less precise way what FFC captures more exactly.

3. Data and Methods

To examine potential correlations between word classes, FFC, and rates of reduction, this study utilizes two sets of data with dependent variables coded as part of previous research; the diachronic development of Latin FV- words in Spanish (F- > [h] > Ø) (Brown & Raymond 2012), and the synchronic reduction of word-initial /s/ in both Traditional New Mexican and Chihuahua, Mexico Spanish (Brown 2005, Brown & Torres Cacoullós 2003). The FV- data are extracted from the historical text *La Celestina* (Fernando de Rojas) and consider the Modern Standard Spanish (MSS) outcome of the FV- words; having a word initial [f] (spelled *f*) or Ø (spelled *h*). The *Celestina* text contains 66,000 words and 1,848 word tokens derived from FV- which provided 346 different word types for analysis (paradigmatically related forms were not conflated into one lemma). The historical text was used to calculate FFC for each type by taking the proportion of tokens preceded by a non-high vowel (/a, e, o/). These contexts were contrasted with all other preceding phonological environments (i.e., high vowel, diphthong, consonant, and pause). FFC is defined for each word type as the proportion of instances of a word following a non-high vowel out of the total number of tokens of that word that appeared in the text. Lastly, FV- words were coded as being either a noun, verb, or adjectival (adjective or adverb).

The /s-/ data stem from two separate corpora of historically related dialects; recorded conversations from native speakers of Chihuahua, Mexico (Torres Cacoullós 2000) and interviews making up part of the New Mexico Southern Colorado Linguistic Atlas project (Bills & Vigil 2008). All word-initial cases of /s/ (orthographic *s*, as well as *z*, *c* + *i,e*) had been labeled as either reduced ([h], Ø) or maintained ([s]) (Brown 2005, Brown & Torres Cacoullós 2003). These corpora yielded 2707 tokens from 196 different /s-/ word types. The New Mexican corpus (approximately 97,000 words) was used to calculate FFC for each type by taking the proportion of tokens preceded by a non-high vowel (/a, e, o/). Like the FV- data, these contexts were contrasted with all other preceding

phonological environments (i.e., high vowel, diphthong, consonant, and pause). Lastly, all tokens were coded for word class. The following section outlines results of quantitative analyses conducted on these data sets.

4. Results

The irregular MSS outcome of FV- words is widely held to be a result of language external forces (dialect and language contact in 13th century Peninsular Spanish), and word classes are not widely considered in the analysis of F- > [h] > Ø (Penny 1991). Are there any correlations in the data between word classes and the lexical types that in MSS maintain [f] rather than Ø (*fumar*, for example, vs. *humo*, both derived from Latin FUMARE)? Table 3 summarizes the MSS outcome of each of the word classes examined; adjectivals, nouns, and verbs.

Table 3: MSS outcomes ([f] or Ø) for Latin FV- types

Word class	MSS [f] (<i>f-</i>) (N)	MSS Ø (<i>h-</i>) (N)	% FV- types with reduced initial phone in MSS
Adjectivals <i>hermoso</i> ‘beautiful/handsome’, <i>hasta</i> ‘until’, <i>falso</i> ‘fake, false’, <i>fácil</i> ‘easy’	21	11	34
Nouns <i>hijo</i> ‘son’, <i>hormiga</i> ‘ant’, <i>fantasma</i> ‘ghost’, <i>fortuna</i> ‘fortune’	38	49	56
Verbs <i>hacer</i> ‘to make/do’, <i>hablar</i> ‘to talk/speak’, <i>forzar</i> ‘to force’, <i>firmar</i> ‘to sign’	67	160	70
Total	126	220	64

As Table 3 makes evident, with the 346 FV- types analyzed, there is an unequal distribution with regard to word class and reduced initial phone. For instance, in MSS significantly fewer ($X^2 = 4.50772$, $p = 0.03$) types of adjectivals have lost the word-initial F- (34%) than nouns (56%). Similarly, the proportion of nouns (56%) with a reduced word-initial phone is significantly less ($X^2 = 5.668053$, $p = 0.02$) than the proportion of verbs (70%) realized in MSS with Ø (*h-*). Why might this be the case? One explanation could lie in the reducing effect of word frequency (e.g.; Bybee 2001; Phillips 2006). However, in this case, there are no significant differences between word classes with regard to token/word frequency. There are, however, significant differences in average FFC values across the word classes. Verbs have a significantly higher FFC (63) than nouns (50) [$t(313) = 2.59$, $p = .01$]. Similarly, verbs have a significantly higher FFC than adjectivals (40) [$t(258) = 3.12$, $p = .002$]. Table 4 summarizes this finding.

Table 4: Average word frequency per million and average FFC for FV- word classes

Word class	Avg. Word Frequency per million	Avg. FFC	% FV- types with reduced initial phone in MSS
Adjectival	76	40	34
Noun	83	50	56
Verb	74	63	70

Therefore, it is the case that verbs are used in discourse significantly more often in phonological contexts conducive to reduction compared to both nouns and adjectives, and, verbs have significantly more reduced types (70%) than nouns (56%) and adjectivals (34%) in MSS.

This type of significant correlation with word class, FFC and reduction rates, as seen for Puerto Rican /d/ (Table 2) and for the diachronic development of FV- in Spanish (Table 4), is also evident in

the synchronic variation of word-initial /s/ reduction in Chihuahua and New Mexico. In these initial /s/ reducing varieties, different word classes¹ correspond to different rates of reduction. This information is summarized in Table 5. Like the FV- data, there are significantly different usage patterns in discourse between word classes. Verb types, for instance, have a significantly higher FFC (64) than both nouns (46) and adjectivals (45) [Verbs ~ Noun: $t(164) = 5000000$, $p < 0.01$, Verbs ~ Adjectival: $t(135) = 3.03$, $p < 0.01$].

Table 5: Rates of word-initial /s/ reduction ([h], Ø) in Chihuahua and New Mexico by word class

Word Class	N	% red	Average FFC
Sí	625	6	15
Other (preposition, conjunction)	183	5	33
Adjectival	172	8	45
Noun	331	13	46
<i>Se</i>	746	24	56
Verb	650	28	64
Total	2707	17	45

What is more, FFC remains a significant predictor of variation even when bringing other measures of variation under statistical control (preceding phonological context, following phonological context, stress, word class). Table 6 summarizes analyses conducted with the R statistical package (R Development Core Team) using logistic regression on the initial /s/ data.

Table 6: Word-initial /s/ retention [s] in New Mexico and Chihuahua (N = 2707)

Variable (application value)	<i>p</i>	Odds Ratio Effect
Previous phonological context (consonant)		
Preceding non-high vowel (/a,e,o/)	0.000	-0.8444
High vowel & diphthong (/i,u/)	0.000	0.5812
Preceding pause	ns	0.3624
Following phonological context (high vowel)		
Non-high vowel	0.000	-0.7905
Stress (stressed)		
Unstressed	0.000	-0.9249
FFC	0.03	-0.7188
Word class (adjectival)		
Noun	ns	0.3915
Verb	ns	-0.2761
Other (preposition, conjunction, clitic)	ns	0.2988

Nagelkerke $r^2 = -0.4702456$; Log likelihood -1054.447 (df=10)

Table 6 lists linguistic factors that favor retention of the /s/ in these varieties. Importantly for the purposes of the present analysis, FFC is selected as significantly constraining initial /s/ realizations in the corpora, but word classes are not. The higher the FFC of the lexical item (the more often that word

¹ The lexical types *sí* and *se* were separated out owing to their exceedingly high word frequencies which set them apart from other lexical /s-/ types.

is used in a post non-high vowel context), the less likely it is to be articulated as a sibilant ([s]) as reflected by the coefficient (-0.7188).

5. Discussion and Conclusion

The data from Spanish analyzed here suggest evidence of the *cumulative* effect of correlations where the phonetic differences arising in natural speech have become lexicalized (Bybee 2001). Results indicate that while significant differences exist in average rates of reduction between nouns, verbs, and adjectivals, such differences are epiphenomenal and derived through use (Bybee 2002). The results suggest representational change in the lexicon through repeated exposure of words to reducing environments and challenge proposals that word classes *per se* constrain variation.

This paper has argued that word class effects may be manifestations of differential patterns of use. If the various discourse contexts differ in the degree to which they favor or disfavor a specific change, we would predict word class effects of the type summarized in Phillips (2006). The dissimilar patterns of use between different grammatical categories could also shed new light on the study of homonymic pairs (Gahl 2008). It is likely that homonyms, particularly if split across word classes, are used in markedly different discourse environments. Such correlations with distinct phonetic environments may impact reduction rates.

Methodologically, the FFC measurement is advantageous because it allows for quantification in scalar terms (File-Muriel 2010, File-Muriel & Brown 2011). Further, FFC has a plausible articulatory explanation (Raymond & Brown 2012) in that it quantifies the cumulative impact of localized phonetic contexts on lexical forms; phonetic context being widely acknowledged to constrain phonological variation. Lastly, viewed from within the usage-based framework that presupposes grammar to be emergent (Bybee 2001, 2010), FFC is a cognitively plausible linguistic variable.

The type of work summarized here measures the cumulative articulatory effect of a reducing environment in the context immediately preceding a word. Words also vary in their probability of occurrence in environments that encourage reduction through other mechanisms. Factors known to promote reduction include faster speech, lack of prosodic salience, and greater predictability. It remains to be determined whether FFC based upon measures of these factors might also be found to correlate significantly with reduction.

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