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**SPANISH EPENTHESIS:
FORMAL AND PERFORMANCE PERSPECTIVES¹**

David Eddington
University of New Mexico
davee@unm.edu

Epenthesis of /e/ before *sC*- clusters in Spanish is documented word-initially (e.g., *esfera*) as well as in word-internal contexts (e.g., *subestimar*). Cases of alternating epenthesis also exist (e.g., *arterio-sclerosis / arterioeclerosis*). Epenthesis is examined in the formal frameworks of lexical phonology and optimality theory. Both formal analyses are able to account for the majority of the data presented, however, each requires some arguably ad hoc manipulation in order to do so. From a performance standpoint, it is argued that epenthesis plays no role in the processing of native Spanish words. The appearance of epenthesis in loan words (e.g., *stress* > *estrés*) is explained in terms of schemas. The fact that /e/ emerges as the epenthetic vowel, as well as the fact that epenthesis applies so as not to break up *sC*- clusters, is the result of a phonotactic schema that has its origins in a historical epenthesis process that is synchronically defunct. Adopted words epenthesize with /e/ because /e/ is the most commonly occurring vowel before word initial *sC*- clusters. In addition, epenthesis occurs to the left of the *sC* cluster because word initial *seC*- is much less common than word initial *esC*-. Cases of alternating epenthesis are due to the varying degrees of morphological decomposition different speakers perform.

1. Introduction

In classical generative linguistics, the initial *e*- of words such as *esfera* 'sphere', *eslabón* 'link', and *estructura* 'structure' was seen as a predictable element that could be derived by rule, and thus did not need to appear in the underlying representation. Therefore, epenthesis of *e*- was derived by rule (e.g., Cressey 1978):

(1) $i \rightarrow e / \# _ s [+cons]$

In this way, [esfera] was derived from /sfera/. Further evidence for the existence of the rule is adduced by the fact that it applies to loanwords (e.g., *estándar* < standard; *esmóquin* < smoking jacket) as well as in interlanguage phonology (e.g., Scott > [eskot]; sport > [espor]).

The purpose of this paper is twofold. First, I review the ability of extant formal analyses to account for a wide variety of Spanish words that undergo epenthesis, and I present an optimality theory account of the process. Second, I explore the role that epenthesis has as far as linguistic performance is concerned. In both

cases, the crucial test of an analysis is that it correctly account for the existence of epenthesis following certain prefixed words such as *antiestético* 'unaesthetic', and *interestatal* 'interstate', as well as the lack of epenthesis in other prefixed words such as *proscribir* 'to expatriate', and *transpirar* 'to perspire'. Since I differentiate between formal and performance models, these terms need precise definition.

2. Formal and performance models.

The major difference between formal and performance models may be couched in terms of the competence/performance distinction. Formal models deal with competence, which is defined as a speaker's knowledge of language (Chomsky 1980: 205). Competence is an idealized concept which comprises the system of rules, representations, and constraints which are thought to underlie a speaker's ability to produce and understand language. Formal models usually claim to reflect facts about an idealized speaker-hearer. Performance models, on the other hand, attempt to explain how actual speakers put linguistic knowledge to use in the course of the real-time task of speech production and comprehension.

In other words, formal linguistics is a realm of inquiry which deals with axiomatizations about linguistic structure which 'make it possible to deduce all true statements about the system from a small set of prior assumptions about its nature' (Kac 1974: 44). It reflects 'a kind of abstract complexity with which somehow the human brain must cope' (Goyvaerts 1978: 12), but does not necessarily spell out how the brain copes with it. Most linguists² would agree that formal representations in the form of rules, derivations, and constraints do not relate to the actual processing of language (performance) but only to competence (e.g., Bradley 1980:38; Chomsky and Halle 1968:117; Kiparsky 1975:198; 1982:34). For example, Kager (1999:26) states that 'explaining the actual processing of linguistic knowledge by the human mind is not the goal of the formal theory of grammar, ... a grammatical model should not be equated with its computational implementation'. The computational implementation belongs to domain of performance.

3. A rule-based analysis of epenthesis.

The fact that words beginning with *sC-* form illicit syllables, along with the fact that such clusters become *esC-* in borrowings prompted a number of early researchers to include a rule such as (1) in their formal analyses (Cressey 1978, Harris 1983, 1987; Hooper 1976; Morgan 1984). Harris and Cressey explicitly note that this rule only applies word initially. However, while epenthesis appears to occur mainly at the beginning of words as in (2), Eddington (1992) points out that epenthesis is not uniquely a word-initial process (3).

(2) /sfera/	→	<i>esfera</i>	'sphere'
/skribir/	→	<i>escribir</i>	'to write'
/in + skribir/	→	<i>inscribir</i>	'to inscribe'
/emi + sferio/	→	<i>hemisferio</i>	'hemisphere'
/arterio + sklerosis/	→	<i>arteriosclerosis</i>	'arteriosclerosis'

(3) /semi + sfera/	→	<i>semiesfera</i>	'semisphere'
/des + speransa/	→	<i>desesperanza</i>	'hopelessness'
/inter + stata/	→	<i>interestatal</i>	'interstate'
/anti + stetiko/	→	<i>antiestético</i>	'unaesthetic'

He accounts for this alternation in a lexical phonology framework in which prefixes are attached to stems in two different strata. For example *pro-* belongs to the first stratum while *semi-* belongs to the second, as seen in Table 1.

Table 1.

	CLASS I	CLASS II
STRATUM I	[pro][skribir]	[semi][sfera]
Affixation of Class I Prefixes	[proskribir]	---
Syllabification	[pros.kri.bir]	*[s.fe.ra]
Epenthesis	---	[es.fe.ra]
STRATUM II		
Affixation of Class II Prefixes	---	[semiesfera]
Syllabification	---	[se.mies.fe.ra]
Epenthesis	---	---

The words in Tables 2-4 appear in *Diccionario de la lengua española* (Real Academia Española 1984), with the exception of those words marked with asterisks. Based on the data in Table 2, the prefixes *ad-*, *arterio-*,³ *hemi-*, *hipo-*, *peri-*, *pro-*, *tele-*, and *trans-* are Class I prefixes which are attached in Stratum I. Table 3 demonstrates that *contra-*, *inter-*, *pos(t)-*, *semi-*, and *super-* belong to Class II which are affixed in Stratum II.

Table 2: Examples of words containing Class I prefixes
(All words appear in Real Academia Española 1984).

adscrito 'assigned'	escrito 'written'
adstrato 'adstratum'	estrato 'stratum'
adstringir 'constrict'	estringir 'restrict'
arteriosclerosis 'arteriosclerosis'	esclerosis 'sclerosis'
hemisferio 'hemisphere'	esfera 'sphere'
hemisférico 'hemispherical'	esférico 'spherical'
hipostático 'hypostatic'	estático 'static'
hipóstilo 'column-supported'	estilo 'style'
periscopio 'periscope'	escopio ^{4*} 'scope'
proscribir 'expatriate'	escribir 'write'
prosperar 'prosper'	esperar 'hope'
prostático 'prostatic'	estático 'static'
telescopio 'telescope'	escopio* 'scope'
telesférico 'ski lift'	esférico 'spherical'
telesquí 'ski lift'	esquí 'ski'

transcribir 'transcribe'	escribir 'write'
transcurrir 'elapse'	escurrir 'drain'
transpirar 'perspire'	espirar 'exhale'

Table 3: Examples of words containing Class II prefixes.

contraescarpa 'counterscarp'	escarpa 'scarp'
contraescota 'preventer sheet'	escota 'sheet'
contraescotín 'preventer sheet'	escotín 'top sail sheet'
contraescritura 'counterdeed'	escritura 'deed'
contraespionaje* 'counterespionage'	espionaje 'espionage'
contraestay 'counterstay'	estay 'forestay'
interestatal 'interstate'	estatal 'state'
interestelar 'interstellar'	estelar 'stellar'
pos(t)escolar* 'after-school'	escolar 'after-school'
semiesfera 'semisphere'	esfera 'sphere'
superestrato 'superstratum'	estrato 'stratum'
superestructura 'superstructure'	estructura 'structure'

The division of prefixes into two classes is not made merely on their relationship to stem epenthesis. It has been observed that prefixes that are attached in later strata tend to be more productive, and to be more semantically transparent than those of earlier strata (Kiparsky 1982:8; Mohanan 1986:56-58). So far, this appears to be true as far as Spanish is concerned. The prefixes *contra-*, *inter-*, *pos(t)-*, *semi-*, and *super-* are much more productive than the Class I prefixes. In addition, the meaning of the words in Table 3 is easily deriveable from the meaning of the prefix plus the meaning of the stem. The same is not true of Class I prefixes. Another tendency of semantically transparent prefixes is that they are more likely to be affixed to unbound morphemes (Goldsmith 1990:260). Class II prefixes attach to complete well-formed words (*super* + *estructura* = *superestructura*), while Class I prefixes attach to stems, such as **scribir* and **scopio*, which are bound morphemes that cannot stand on their own as whole words.

The difficulty with this analysis becomes evident upon examining the words in Table 4. What class of prefixes do *anti-*, *des-*,⁵ *in-*, *pre-*, *re-*, *sobre-*, *sub-*, and *yugo-*,⁶ belong to?

In certain lexical items, they appear in stems that have undergone epenthesis (e.g., *antiestético*, *subespecie*), while in other cases they are affixed to unepenthed stems (*antistrofa*, *subscribir*). As far as *pre-*, *re-*, and *sobre-* are concerned, whether epenthesis has applied or not may be masked by the fact that series of identical vowels in Spanish may be given a long or short duration. This is seen in words such as *alcohol*, *creer*, and *moho* ([alkol]~[alko:l], [krer]~[kre:r], [mo]~[mo:]). I submit that this phonetic alternation has given rise to alternate spellings that do not accurately reflect whether there are two contiguous front mid-vowels at some point in the derivation.

Table 4.

antiesclavista* 'abolitionist'	esclavista 'proslavery'
antiescorbútico 'antiscorvy'	escorbuto 'scurvy'
antiespasmódico 'muscle relaxant'	espasmo 'spasm'
antiestético 'unaesthetic'	estético 'aesthetic'
antistrofa 'antistrophe'	estrofa 'stanza'
descampar 'stop raining'	escampar 'stop raining'
describir 'describe'	escribir 'to write'
descamar 'to scale'	escamas 'scales'
desescombrar 'to remove rubble'	escombros 'rubble'
describir 'to perform a literary analysis'	escribir 'to write'
desespañolizar 'to despanishize'	españolizar 'to spanishize'
desesperanza 'hopelessness'	esperanza 'hope'
desestancar 'to release'	estancar 'to jam'
desestañar 'to unsolder'	estañar 'to tin'
desestimar 'belittle'	estimar 'to esteem'
despabilar 'to wake up'	espabilar 'to wake up'
desparcir 'to scatter'	esparcir 'to scatter'
inescrutable 'inscrutable'	escrutar 'to scrutinize'
inescudriñable 'inscrutable'	escudriñar 'to scrutinize'
inesperado 'unexpected'	esperado 'expected'
inestable 'unstable'	estable 'stable'
inestancable 'unjamable'	estancar 'to jam'
inestimable 'invaluable'	estimado 'valued'
inscribir 'to inscribe'	escribir 'to write'
insculpir 'to insculpt'	esculpir 'to sculpt'
inspirar 'to inspire, inhale'	espirar 'to exhale'
pre(e)scolar* 'preschool'	escolar 'school'
preescribir 'to prewrite'	escribir 'to write'
preestablecido 'preestablish'	establecer 'to establish'
prescribir 'to prescribe'	escribir 'to write'
rescribir 'to rewrite'	escribir 'to write'
restablecer 'to reestablish'	establecer 'to establish'
reestreno 'second debut'	estreno 'debut'
reestructurar 'to restructure'	estructurar 'to structure'
resplandor 'brilliance'	esplendor 'brilliance'
restringir 'to restrict'	estringir 'to restrict'
sobrescribir 'to overwrite'	escribir 'to write'
sobre(e)sdrújula 'preantepenultimate'	esdrújula 'antepenultimate'
sobrestadía 'extra lay day'	estadía 'stay'
sobrestimar 'overestimate'	estimar 'to esteem'
subscapular 'subscapular'	escapular 'scapular'
subespecie 'subspecies'	especie 'species'
subestimado 'underestimated'	estimado 'esteemed'
substrato 'substratum'	estrato 'stratum'
subscribir 'to subscribe'	escribir 'to write'

substancia 'substance'
yugoeslavo 'Yugoslavian'

estancia 'stay'
eslavo 'Slav'

In order to account for many of the remaining inconsistencies, one may assume, as does Eddington (1992), that words such as those in Table 4 contain different prefixes that have the same phonological shape. That is, there are two *re-* prefixes, *re*₋₂ meaning roughly 'again', and *re*₋₁ whose meaning is opaque. Transparent suffixes are attached to unbound stems that have undergone epenthesis, and whose meaning is derivable from the meanings of the prefix and the stem. Following this line of reasoning, there is one prefix *anti*₋₂ meaning 'against', *des*₋₂ meaning 'not, against', *in*₋₂ meaning 'not', and *sub*₋₂ meaning 'under, inferior'. The meanings of *anti*₋₁, *des*₋₁, *in*₋₁, *re*₋₁, and *sub*₋₁ are opaque. Words containing the opaque prefixes are attached in Stratum I, while those with transparent prefixes are attached in Stratum II as in Table 5.

Table 5.

	CLASS I	CLASS II
STRATUM I	[des ₁][skribir]	[des ₂][stañar]
Affixation of Class I Prefixes	[deskribir]	---
Syllabification	[des.kri.bir]	*[s.ta.ñar]
Epenthesis	---	[es.ta.ñar]
STRATUM II	---	---
Affixation of Class II Prefixes	---	[desestañar]
Syllabification	---	[de.ses.ta.ñar]
Epenthesis	---	---

The optional shortening of sequences of identical contiguous vowels (i.e., /ee/) in words beginning with the prefixes *pre-*, *re-*, and *sobre-*, along with the assumption that several apparently unitary prefixes are actually instances of two different prefixes, allows the majority of the words in Table 4 to be elegantly accounted for. Nevertheless, *descamar*, *desperanza*, and *subscapular* appear without epenthesis as if they contained Class I prefixes with opaque meanings, in spite of the fact that their meanings are clearly derivable from their constituent morphemes. *Yugoeslavo*, on the other hand, would have to undergo affixation in Stratum II, yet the meaning of *yugo-* is obscure. Of course, in an analysis of this sort it is always possible to simply consider these words exceptional. Another approach would be to abandon the attempt to provide independent semantic motivation for the distribution of prefixes, and stipulate that any prefixed stem that undergoes epenthesis is affixed in Stratum II.

Perhaps the greatest difficulty a lexical phonological analysis encounters is in accounting for the data in Table 6.

Table 6.

Hi=Unprefixed frequency higher than frequency of prefixed word
Lo=Unprefixed frequency lower than frequency of prefixed word
X=No independent stem exists
?=Unable to determine

		esC	ØsC	
anti(e)strofa 'antistrophe'	estrofa 'stanza'	0	0	?
arterio(e)sclerosis 'arteriosclerosis'	esclerosis 'sclerosis'	5	12	Hi
des(e)scamar 'to scale'	escamas 'scale'	0	5	Hi
des(e)scombrar 'to remove rubble'	escambros 'rubble'	2	0	Hi
des(e)stimar 'belittle'	estimar 'to esteem'	16	0	Hi
des(e)speranza 'hopelessness'	esperanza 'hope'	655	2	Hi
hemi(e)sferio 'hemisphere'	esfera 'sphere'	0	68	X
hemi(e)sférico 'hemispherical'	esférico 'spherical'	0	2	Hi
in(e)scrutable 'inscrutable'	escrutar 'to scrutinize'	17	0	Hi
in(e)sperado 'unexpected'	esperado 'expected'	306	1	Hi
pre(e)scolar 'preschool'	escolar 'school' adj.	6	0	Hi
pre(e)stablecido 'preestablish'	establecer 'to establish'	12	0	Hi
re(e)scribir 'to rewrite'	escribir 'to write'	21	0	Hi
re(e)stablecer 'to reestablish'	establecer 'to establish'	3	91	Hi
re(e)streno 'second debut'	estreno 'debut'	7	0	Hi
re(e)estructurar 'to restructure'	estructurar 'to structure'	21	0	Hi
re(e)splendor 'brilliance'	esplendor 'brilliance'	0	226	Lo
re(e)stringir 'to restrict'	estringir 'to restrict'	0	134	Lo
sobre(e)scribir 'to overwrite'	escribir 'to write'	0	0	?
sobre(e)sdrújula 'preantepenultimate'	esdrújula 'antepenultimate'	0	0	?
sobre(e)stadía 'extra day layover'	estadía 'stay'	0	0	?
sobre(e)estimar 'overestimate'	estimar 'to esteem'	3	1	Hi
sub(e)scapular 'subscapular'	escapular 'scapula'r	0	0	?
sub(e)specie 'subspecies'	especie 'species'	2	0	Hi
sub(e)stimado 'underestimated'	estimado 'esteemed'	12	1	Hi
sub(e)strato 'substratum'	estrato 'stratum'	0	44	Hi
super(e)strato 'superstratum'	estrato 'stratum'	0	0	?
super(e)estructura 'superstructure'	estructura 'structure'	16	0	Hi
tele(e)sférico 'ski lift'	esférico 'spherical'	0	0	?
tele(e)esquí 'ski lift'	esquí 'ski'	0	6	Hi
Yugo(e)slavia 'Yugoslavia'	eslavo 'Slav'	0	38	X
yugo(e)slavo 'Yugoslavian'	eslavo 'Slav'	2	54	Lo

These data were originally obtained by searching Spanish language pages on the World-wide Web for instances of the words from Tables 2-4. Instances were sought both with and without the epenthetical /e/. One question that is of interest is which of the alternating forms in Table 6 is more common. Unfortunately, using the internet to determine the actual frequency of occurrence of a given word is not possible. In order to better quantify the results of the internet search, the rate of occurrence of these words was verified in two frequency dictionaries (Alameda

and Cuertos 1995; Sebastián, Cuertos, and Carreiras 2000). A count of all inflectional variants of these words (e.g., *re(e)scribir*, *re(e)scrito*, *re(e)scriben* etc.) appears in the third and fourth columns of Table 6. For example, the frequency dictionaries contain five instances of *arterioesclerosis*, and twelve instances of *arteriosclerosis*. It may be tempting to dismiss the occurrence of some of these words as mere spelling errors. Nevertheless, errors often provide very telling information, and should not be discarded offhand, especially when the 'errors' appear in the speech of many different speakers.

It is apparent that accounting for these alternations would require the same word beginning with the same prefix to undergo affixation in both strata, which is an undesirable state of affairs. For example, the meanings of *antiestrofa*, *restringir*, *sobreestadía*, *telesquí* *Yugoeslavia* and *yugoeslavo* cannot be clearly derived from their parts, as can other words with Class II prefixes, yet they would have to undergo affixation in Stratum II. As Goldsmith notes (1990:264), 'assigning a suffix [read--prefix] to both classes without independent justification can, under certain circumstances, be just a sign that the model is in trouble, and is making wrong predictions'. Although the lexical phonological analysis is able to account for far more of the cases presented than early generative analysis could, (because they did not consider cases of word-medial epenthesis), it does not render a satisfying account of the full range of data presented herein without resorting to what could be considered ad hoc manipulation.

4. An optimality theory analysis

The most influential model of formal phonology to be developed in past ten years is arguably optimality theory (McCarthy and Prince 1994a, 1994b; Prince and McCarthy 1993; see Kager 1999, and Archangeli and Langendoen 1997 for introductory texts). It dispenses with the idea of ordered rules that specify how derivations are to proceed. Instead, it assumes that a variety of different outputs are generated, and the task of the grammar is to evaluate each output in terms of how well it conforms to stipulated constraints. Constraints are violable statements that are ranked hierarchically. A constraint that is ranked lower may be violated as long as a higher ranking constraint is not violated.

The following analysis draws on the four constraints that are most relevant to epenthesis in Spanish: morpheme contiguity (M-CONT), sonority (SONORITY), vowel faithfulness (FAITH-V), and no coda (NOCODA). Morpheme contiguity prohibits the insertion of elements into a morpheme. In regards to Spanish epenthesis, this constraint was noted at an early date by Hooper (1976: 234-5). Sonority stipulates that in a syllable, the most sonorous elements must be closest to the nucleus. Vowel faithfulness suggests that only vowels that exist in the underlying representation may appear in the surface structure, which means that epenthesis is prohibited.⁷

Table 7.

/spera/	M-CONT	SONORITY	FAITH-V	NOCODA
a. spe.ra		*!		
b. sE.pe.ra	*!		*	
☞ c. Es.pe.ra			*	*

As is seen in Table 7, the correct constraint ranking is: M-CONT, SONORITY >> FAITH-V, NOCODA. The unepenthesized output **spera* violates sonority because in the syllable [spe], the [p] is closer to the nucleus than [s], yet [p] is less sonorous. The output **sepera* allows epenthesis morpheme-internally in violation of morpheme contiguity. It also violates vowel faithfulness by inserting an epenthetic vowel that does not appear in the underlying representation. The correct outcome, *espera* is chosen in spite of the fact that it violates vowel faithfulness by undergoing epenthesis, as well as violating the no coda constraints by containing the closed syllable [es]. The correct outcome emerges as a result of the fact that the constraints it violates are ranked below those it does not violate.

Table 8.

/in+spirado/	M-CONT	SONORITY	FAITH-V	NOCODA
☞ a. ins.pi.ra.do				*
b. i.nEs.pi.ra.do			*!	*
c. in.sE.pi.ra.do	*!		*	*
d. in.spi.ra.do		*!		*
/tele+skopio/				
☞ a. te.les.co.pio				*
b. te.leEs.co.pio			*!	*
c. te.le.sE.co.pio	*!		*	
d. te.le.sco.pio		*!		

Table 8 demonstrates how this analysis can be extended to the words in Table 2 without modification. However, prefixed words that attach to an epenthesized stem, such as those in Table 3, are incorrectly predicted not to undergo epenthesis. In Table 9, the predicted outcomes are **semisfera* and **insperado* rather than the correct *semiesfera* and *insperado*. Clearly, another constraint is at work here which I call semantic transparency (SEM-TRANS).

Semantic transparency dictates that when the meaning of an affixed word is clearly derivable from its constituent parts, the affix must be attached to an unbound stem. Consider the English word *deceive*. It is composed of the prefix *de-* and a root *ceive*. The meaning of the word is not derivable from its parts, and *ceive* is a bound morpheme, therefore, *deceive* does not violate SEM-TRANS. *Reread*, is also composed of a prefix and root, but the meaning 'to read again' is derivable from the combination of the meanings of the two morphemes. Semantic transparency is not violated in this case either since *read* is an unbound morpheme.

Table 9.

/in+sperado/	M-CONT	SONNORITY	FAITH-V	NOCODA
☞ a. * ins.pe.ra.do				*
b. i.nEs.pe.ra.do			*!	*
c. in.sE.pe.ra.do	*!		*	*
d. in.spe.ra.do		*!		*
/semi+sfera/				
☞ a. * se.mis.fe.ra				*
b. se.miEs.fe.ra			*!	*
c. se.mi.sE.fe.ra	*!		*	
d. se.mi.sfe.ra		*!		

Table 10 demonstrates a case in which SEM-TRANS is violated. SEM-TRANS allows epenthesis in *inesperado* because the meaning 'not expected' is derivable from the meaning of the prefix plus that of the root, and *esperado* is an unbound morpheme. By the same token, the meaning of *inspirado* cannot be derived from its constituent parts. Therefore **inspirado* is not allowed, since **esperado* is not an extant unbound morpheme. (The constraint ranking is: SEM-TRANS, M-CONT, SONORITY >> FAITH-V, NOCODA. NOCODA and SONORITY are essentially constraints on syllabification, which is not an important issue in the present analysis, and do not affect the outcome, therefore, they will not be included in the remainder of the discussion.)

Table 10.

/in+spirado/	SEM-TRANS	M-CONT	FAITH-V
☞ a. inspirado			
b. inEspirado			*!
c. insEpirado		*!	*
/in+sperado/			
a. insperado	*!		
☞ b. inEesperado			*
c. insEperado	*!	*	*

The difficulty with this analysis arises in accounting for the cases of variable epenthesis in Table 6. For example, *substrato* with epenthesis would be predicted given the constraints and rankings presented so far (SEM-TRANS, M-CONT >> FAITH-V). However, one could argue that *substrato* and other exceptionally behaving words could be explained by considering a differing constraint ranking, namely FAITH-V >> SEM-TRANS, M-CONT as in Table 11.

Table 11.

/sub+strato/	FAITH-V	SEM-TRANS	M-CONT
☞ a. substrato		*	
b. subestrato	*!		
c. subsetrato	*!	*	*

This reversal in constraint rankings works well for semantically transparent words, but does not explain epenthesis in the semantically opaque words *antiestrofa*, *hemiesferio*, *reesplandor*, *restringir*, *sobreestadia*, *telesférico*, *telesquí*, *yugoeslavia*, and *Yugoeslavia*. Regardless of the ranking, these words will be predicted to occur without epenthesis (Tables 12 and 13). Nevertheless, the frequency information in Table 6 shows that the optimality analysis correctly predicts the more frequent unepenthesized version of these words, and only has difficulties with the arguably odd epenthesized counterparts that are infrequently occurring forms.

Table 12.

/emi+sferio/	SEM-TRANS	M-CONT	FAITH-V
☞ a. hemisferio			
b. hemiEsferio			*!
c. hemiseferio		*!	*

Table 13.

/emi+sferio/	FAITH V	SEM-TRANS	M-CONT
☞ a. hemisferio			
b. hemiEsferio	*!		
c. hemiseferio	*!		*

Whether or not the optimality account is preferable to the lexical account is open to debate. Both models require some manipulation (i.e., affixation in both strata or differential constraint rankings) in order to handle the majority of the data.

5. A performance analysis.

In Section 2, I differentiate between formal and performance models of language. Formal models are not generally thought of as specifying the actual mechanisms used in processing language. However, the distinction between formal and performance models is clouded because formal mechanisms are often spoken of as if they relate to steps in actual processing (Carr 2000; Eddington 1996). It is also not uncommon for a formal model to appeal to performance-related evidence in order to support a formal mechanism (Stemberger 1996). In order to avoid these pitfalls, I chose to divide the present discussion into its formal and performance aspects.

There are essentially three reasons for including a rule of epenthesis in a formal grammar. The first is that /e/ before sC- is predictable, and therefore may not form part of the lexicon. This formal motivation contrasts with evidence from performance that shows that detailed information about individual words is stored in memory (Brown & McNeill, 1966; Bybee, 1994; Pisoni, 1997; Palmeri, Goldinger, & Pisoni, 1993; Goldinger, 1997), not merely the unpredictable or contrastive characteristics. Therefore, this motivation does not apply to performance.

Another reason for assuming a formal rule of epenthesis is that one is needed in order to explain the /e/-∅ alternation that occurs in words containing the same stem (e.g., *in∅scribir*, *pro∅scribir*, *reEscribir*, *preEscribir*). From a performance

standpoint, this sort of analysis suggests that speakers obligatorily parse morphologically complex words. It is doubtful that the majority of Spanish speakers recognize that *proscribir* is composed of a prefix followed by exactly the same stem found in *reescribir*. Experimental evidence suggests that many morphologically complex words are stored as wholes rather than segmented into morphemes (Alegre and Gordon 1999; Baayen, Dijkstra, and Schreuder 1997; Butterworth 1983; Bybee 1995; Manelis and Tharp 1977; Sereno and Jongman 1997). Therefore, it is more likely that both words have individual entries in the mental lexicon. Of course, the stems of these words may be linked to each other due to their phonological similarity, but not their semantic similarity.

The third reason given for a rule of epenthesis is that a rule appears to apply to foreign borrowings, as well as in interlanguage phonology (*stress* > *estrés*; *stay* > [estej]). This fact surely deserves treatment in a model of linguistic performance which I will address later. Nevertheless, the application of epenthesis to foreign words may not be construed as evidence that the same productive epenthesis process applies each time speakers process a native Spanish word such as *esperar* or *desesperanza*. Epenthesis in native words must be viewed as an unproductive process (Terrell 1983). That is, the /e/ in a word such as *estufa* 'stove' is not missing in the mental representation of the word, only to be attached in the course of production. Therefore, a performance model must assume that words are learned and stored in a form closely resembling surface structure, in other words, they are stored along with any historically epenthetic vowels they may contain. The burden of proof that a word such as *esfera* is actually stripped of its initial vowel in the course of processing, and stored as *sfera*, only later to undergo epenthesis, falls to those who would make such a claim.

If epenthesis in native words is not a productive process, and speakers merely learn each word on an item-by-item basis, how can the alternations in Table 6 be explained? The formal analyses presented earlier hold that the unmarked state of affairs is for semantically transparent words to be composed of a productive prefix followed by an unbound stem beginning with /e/. Semantically opaque words that are composed of an unproductive prefix followed by a bound stem without an epenthetic /e/ are also unmarked. The frequency data corroborates this because where there are alternative forms, the unmarked form is more frequent than the marked form. The only exceptions are *arteriosclerosis*, *descamar*, *restablecer*, and *substrato*. It may be that the relatively high frequency of *restablecer* allows it to maintain its irregular, unepenthesized form. On the other hand, I submit that the less frequent epenthesized forms *arterioesclerosis*, *desescamar*,⁸ and *subestrato* may be considered regularizations since they are semantically transparent forms containing an unbound stem.

In a study by Hay (2001), two types of English words were contrasted: 1) words such as *dishorn* whose stem (*horn*) is more frequent than the prefixed word itself (*dishorn*), and 2) words such as *dislocate* in which the stem (*locate*) is less frequent than the prefixed word (*dislocate*). Hay found that prefixed words such as *dishorn* are more likely to be semantically transparent, and are also more likely to be decomposed into the constituent morphemes *dis-* and *horn*. In contrast, words

such as *dislocate* are more semantically opaque, and less likely to be perceived as morphologically complex.

In regards to the Spanish data, prefixed words such as **spirar* arguably have a stem frequency of zero since their stems do not occur as independent words (Table 2). According to Hay, words containing this sort of stem are less likely to be perceived of as being morphologically complex. By the same token, they are more likely to be semantically opaque. However, in words such as *inesperado*, in which the stem (*esperado*) is also a viable word by itself, the stem frequency may vary, thus resulting in variable degrees of transparency and morphemic decomposition. The last column in Table 6 indicates whether the stem frequency is higher or lower than the whole word frequency. It should not be surprising that the only items in which the stem is less frequent than the entire prefixed word (i.e., *re(e)splendor*, *re(e)stringir*, and *yugo(e)slavo*) are words in which the unepenthesized versions (i.e., *resplendor*, *restringir*, and *yugoslavo*) are more common. In contrast, the majority of words, whose stems are more frequent than their prefixed counterparts, appear more frequently in the frequency dictionaries with epenthesized stems. The only exceptions to this generalization are *arteriosclerosis*, *descamar*, *restablecer*, and *substrato*, which have already been discussed as being marked forms. However, the lack of epenthesis in *hemisférico* and *telesquí* must also be considered exceptional by this account since the stems are more frequent than their prefixed partners. One explanation for their exceptional behavior, as far as Hay's observation is concerned, it is that the meaning of the unproductive prefixes *hemi-*, and *tele-* do not combine with the stems *esférico* and *esquí* in a way that their meaning is deriveable from the parts.

Some of the alternations involving *pre-*, *re-*, *sobre-*, and *tele-* may be due to the fact that sequences of identical vowels may be realized as either a short or long vowel in Spanish. For example, since *preescolar* can alternate between [preskolar] and [preeskolar], the written form may also alternate between *preescolar* and *prescolar*. The long vowels in *reesplendor*, *reestringir*, and *sobreestadía* are unusual since these words are semantically opaque. However, given the alternation between short and long vowels in the language, the long vowel version of these words could be considered hypercorrections based on words such as *reescribir*, *reestablecer*, *reestructurar*, *sobreescribir*, *sobreestimar*, and *sobreesdrújula*.

According to Bybee (1988), the memory representation of high frequency words is stronger than for low frequency words. As a result, high frequency words are stored as entities that are more independent from other words. Low frequency words, on the contrary, are less independent, and are stored with more links to other lexical items. The majority of words that demonstrate apparent alternation between epenthesizing and non-epenthesizing stems are fairly low frequency words. I submit that their low frequency may account for some of the variation that exists. That is, whether or not the semantic relationship between the prefix and stem is perceived may vary from one person to the next. Speakers who perceive the relationship would be more likely to produce an epenthesized stem than those that have not parsed the word into its constituents.

6. Accounting for productive epenthesis

The previous sections dealt with unproductive epenthesis, which I argue is essentially lexicalized, although it demonstrates a small degree of variation. I now turn my attention to the kind of productive epenthesis that occurs when foreign words beginning in *sC-* are either pronounced by Spanish speakers, or adopted into the Spanish vocabulary. One approach to this question is to consider that the historical process, (which originally converted *sC-* clusters in Romance into *esC-* clusters in Spanish), is still in force. Of course, why some Romance languages, such as Spanish, underwent epenthesis while others, such as Italian, did not is a question that the present study does not pretend answer. Although this process is presumably no longer invoked in processing native Spanish words, it could still be in effect and play a part in interlanguage phonology when foreign words with initial *sC-* are nativized.

Another explanation for epenthesis is that epenthesis is a pattern of correspondence that Spanish speakers perceive to hold between foreign and native words. Some patterns of correspondence involve substituting a native phone for a foreign one. For example, French speakers tend to replace English /ð/ with /z/, and English /θ/ with /s/. However, not all correspondences entail replacing a foreign phone or with a native one. Replacement of English /θ/ with Spanish /s/ is a common process even for speakers of Peninsular Spanish which has /θ/ in its phonemic inventory. In a similar vein, Hualde (2000) notes that Spanish words ending in *-o* and *-on* are adopted into Basque with final *-u* and *-oi* respectively. This pattern of correspondence is followed even though the Basque vocabulary contains many native words ending in *-o* and *-on*.

What I would like to propose in the remainder of the paper is that the epenthesis process in Contemporary Spanish is phonotactic in nature. From this perspective, there are two issues to discuss. The first is why the epenthetic vowel is unwaveringly /e/; the second is why epenthesis occurs to form an *esC-* cluster instead of an *seC-* cluster. From a generative perspective, /e/ is the vowel of choice for epenthesis because it has been declared the default vowel in Spanish (Harris 1983, 1987). In terms of performance, the question is not to establish /e/ as the default in terms of how useful it is in a formal rule system, but to determine why it emerges as such in language usage. The most obvious answer is that /e/ is the most frequently occurring vowel in Spanish (Guirao and García Jurado 1990). However, in the context in which productive epenthesis occurs, there is further justification.⁹

Consider a study by Wang and Derwing (1994) on the English vowel alternations [e^j~æ, i^j~ε, a^l~ɪ, o^w~ɔ, u^w~ʌ]. In an experiment, English speakers were presented words and asked to add the suffix *-ity* to produce a new suffixed word. They were also asked to determine how the vowel quality of the stem changes as a result of suffixation. According to proposed formal rules, an [e^j] in the stem should yield a suffixed form with the vowel [æ], while an [i^j] should produce a suffixed form with [ε], and so forth. Many of the subjects did produce suffixed words with the predicted lax vowels. However, one of the most common vowels preferred by the subjects in the suffixed words was [ɔ], regardless of what the original vowel in

the stem happened to be. Wang and Derwing found there are a great many extant English words that end in *-ity* whose stem final vowel is [ɔ]. In other words, many of the subjects' choices appear not to be based on the original vowel in the unsuffixed word, but on the fact that there are many *-ity* words that are preceded by the vowel [ɔ] in the stem. This sort of influence has been explained in terms of product-oriented schema (Bybee and Slobin 1982).

Another example of how a product-oriented schema can exert its influence on phonology is provided by Brown (1999). In Spanish, when /p/ is found in the coda of a syllable, it often suffers some sort of change. It may delete or be given a different point of articulation. For example, the pronunciation of *septiembre* 'September' has been documented as [setjembre], [settjembre], and [sektiembre]. *Pepsi* yields [pesi], [petsi], or [peksi]. Brown observes that in words such as these, the most common change in the point of articulation is from [p] to [k], rather than to [t]. She explains this tendency as due to the fact that /k/ is a much more frequent element in the coda of Spanish words than is /t/.

What I would like to propose is that productive epenthesis in Spanish is the result of a similar sort of product-oriented schema. Epenthesis was an extremely productive process in the development of Spanish from Latin. According to some accounts, this historical process continues to be in effect in contemporary Spanish. However, I argue that the historical process no longer applies in Spanish, even in loan word phonology (e.g., *scanner* > *escáner*). Instead, the historical epenthesis process is responsible for establishing *esC-* as an extremely common cluster. That in turn, affected the phonotactic composition of the language. It is the high frequency of *esC-* at the beginning of words, in contrast to the low frequency of occurrence of *asC-*, *isC-*, *usC-*, and *osC-*, that explains why /e/ emerges as the default vowel.¹⁰

To test the frequency hypothesis in the present synchronic analysis, I obtained a type and token frequency count of these five word-initial clusters. The type frequency count was taken from a word list of about 90,000 entries.¹¹ The list contained 2,367 cases of *esC-* and only 447 combined cases of *a/i/u/o/sC-*. In other words, 82.3% of all instances of *VsC-* have /e/ as the initial vowel. Of course, token frequency is often an important factor in language processing as well. A token count was taken from a 1.1 million word corpus of spoken Spanish (Marcos Marín no date). In this corpus, 21,549 instances of *esC-* were found, and only 3,707 cases of *a/i/u/o/sC-*. Therefore, 85.3% of *VsC-* clusters have /e/ as the initial vowel, or summarizing the data in other terms, *esC-* occurs 5.8 times more often than all other *VsC-* clusters combined. Given these data, it is not surprising that /e/ emerges as the default vowel when Spanish speakers are obliged to adapt a foreign word beginning with *sC-* into Spanish phonological structure.

The next question to be resolved is why epenthesis of /e/ applies to the left of the /s/ in the *sC-* cluster, instead of to the right yielding *seC-*. The fact that epenthesis occurs to the left may be considered somewhat odd in that it creates a closed syllable; Itô (1989: 223) finds that epenthesis processes generally apply so as to create open syllables, not closed ones. I again argue that a process-oriented

schema is at work. As mentioned above, 2,367 words beginning with *esC-* were found in the word list. The question is how frequent the clusters are that would be formed if epenthesis applied to the right of the /s/. The word list contains only 637 words beginning with *seC-*, where *C* indicates any consonant that can occur in a word-initial *esC-* cluster. What this means is that the type frequency of *esC-* clusters is 3.7 times greater than its corresponding *seC-* clusters. The token frequency data indicates an even stronger pull towards *esC-* clusters. There are 21,549 cases of *esC-* clusters, and only 3,885 cases of *seC-* clusters, which means that in spoken Spanish, the former is 5.5 times more frequent than the latter.

Thus far, I have argued that a phonotactic schema is responsible for Spanish epenthesis. However, if the phonetic structure of foreign words is merely modified in accordance with native phonotactic patterns, why do so many borrowings exist that violate Spanish phonotactics? Many fairly recent borrowings admit blatantly un-Spanish final phonemes: *club*, *láptops*, *robots*, *megabit*, *módems*. Evidently, there are a number of competing factors that influence loan word phonology. The incorporation of illicit final phonemes appears to bow to another sort of pressure to maintain the phonology of the foreign language. For example, Janda, Joseph, and Jacobs (1994) document cases in which loan words appear to follow, not the actual phonology of the foreign language from which they were borrowed, but stereotypical notions and often erroneous notions about the phonological patterns of the foreign language. Of course, not all Spanish speakers will consistently pronounce these words with their unusual final phonemes. There is a tendency (which is both dialectal and individual) to delete them, which brings the words in line with Spanish phonotactic patterns (e.g., *club* > *clú*; *laptops* > *láptos*). Nevertheless, this differential treatment appears to be allowed because the words are perceived to be foreign or somehow not 'normal,' thus exempting them from native patterns.

An interesting case of differential treatment given to 'special' words may be found in the pop culture that revolves around the Japanese-produced *Pokémon* cartoon and video game characters. These media have introduced several hundred characters with names such as *Charmander*, *Pikachu*, and *Diglet*. However, as far as the plural morpheme is concerned, the English translation follows the Japanese use of the null morpheme: 'a bunch of Diglet,' 'two Pikachu,' and 'some Charmander'. Informal 'wug' experiments I've performed with children familiar with the *Pokémon* products demonstrate that children produce null plurals of even the most obscure (as well as nonexistent) *Pokémon* characters. At the same time, these same children apply the standard English *-s* when the 'wug' item is not presented as a *Pokémon*.

In sum, two or more factors may compete when the task of pronouncing a foreign word is presented. I argue that phonotactic schema account for epenthesis, and most likely for the deletion of odd word final phonemes as well. However, the retention of word final phonemes that violate Spanish phonotactics suggests a competing factor which may reflect the desire to retain the foreign phonological structure of certain borrowings, especially in words that are perceived as foreign or otherwise different from normal. Exactly why phonotactics wins in the case of

epenthesis and does not always win in the case of odd word-final phonemes is not clear, and calls for more study.

7. Conclusions

Both of the formal analyses of epenthesis are able to account for the majority of the data presented in this paper. However, each requires some ad hoc formal manipulation in order to do so. The performance-based analysis considers epenthesis to have productive and unproductive aspects. Productive epenthesis is thought to apply to foreign words. The fact that /e/ emerges as the epenthetic vowel, as well as the fact that epenthesis applies so as not to break up *sC-* clusters results from the fact that epenthesis is the result of the influence of phonotactic schemas; /e/ is the most commonly occurring vowel before word initially *sC-*, and word initial *seC-* is much less common than word initial *esC-*.

As far as unproductive epenthesis is concerned, the notion of semantic transparency (or opacity) explains the majority of the cases involving words comprised of a prefix plus a stem. The variability seen in the words in Table 6 is due to several factors. Because of the low frequency of most of these forms, speakers may differ in the extent to which they perceive a given word to be morphologically complex, or whether they see a semantic relationship between the prefix and stem. The more a speaker perceives the word to be comprised of a prefix plus stem, and the degree to which the semantics of both elements are seen to combine to give the meaning of the word, the more likely the stem is to be epenthesized. In addition, some of the alternation that occurs in words beginning with *pre-*, *re-*, *sobre-*, and *tele-* may be due to the optional phonetic realization of a sequence of identical vowels (i.e., /ee/) as either a long or short vowel. This phonetic alternation may influence the spelling as well.

NOTES

¹ I express my thanks to Joan Bybee, José Ignacio Hualde, and Devin Jenkins for their critique and input on this paper.

² However, Bromberger and Halle (2000:35) take a realist stance: 'Do speakers REALLY retrieve morphemes from their memory, invoke rules, go through all these labours when speaking? We think they do.'

³ *Arterio-* may be more correctly termed a pseudoprefix.

⁴ Probably a borrowing from English. Refers to a surgical camera.

⁵ When *des-* is affixed to a stem beginning with /s/, the outcome is a simple /s/ not a phonetically or orthographically geminate one (e.g., *des+scombrar* > *descombrar*).

⁶ *Yugo-* may be more correctly termed a pseudoprefix.

⁷ DEP-IO could be used in place of FAITH-V without changing the essence of the analysis.

⁸ The only forms of *descamar* that appear in the frequency dictionary are *descamación* and *descamamiento* that denote a flaking off of skin. This is semantically quite distant from *escamas* 'fish scales.' *Descamar* referring to the process of scaling a fish would be much less likely than *desescamar* in this context.

⁹ Guirao and García Jurado cite other studies in which diphthongs are counted as monophonemic units, so that the /e/ in /we, je, ej/ etc. does not figure into the count of instances of /e/. According to those studies /a/ is the most common vowel.

¹⁰ The reasons why /e/ appeared as the epenthetic vowel when epenthesis was a productive process are obviously different from those I suggest for synchronic epenthesis.

¹¹ Available for download at:

www.umich.edu/~archive/linguistics/texts/lexica/span-lex.zip

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