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Measuring the complexity of the stem alternation patterns of Spanish verbs

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Abstract

This paper is about the stem alternation patterns we observe in the inflection of 3700 Spanish verbs. I treat verbs with such patterns as deviating from the inflection of basic, regular verbs. To set out the right context to understand such patterns, I first present a novel description of the inflection of Spanish regular verbs which benefits from the combination of the traditional approach in Alcoba (1999) and the more innovative stem-based approach in Boyé and Cabredo (2006). All stem alternation patterns in Spanish are morphomic in nature. I present two models of how costly the deviation is for the inflectional system in terms of morphological complexity. In one model, a Kolmogorov-style model, every pattern adds an equal measure of complexity because each one involves a longer description. In an alternative model of complexity, based on implicative relations, the complexity of the system is reduced because the distribution of the patterns is not judged to be equally costly for all of them. Such model is more desirable. However, the descriptions of the implicative relations involved, which I give in the form of notebooks of default-overrides, still need to be stored somewhere in the linguistic system, but probably at a less costly price.

Keywords: morphological complexity, stem alternations, verbal inflection, irregularity

Languages: Spanish, Italian, French

Abbreviations: A aspect; COND conditional; FUT future; GER gerund; IMP imperative; IMPF imperfect; INF infinitive; M mood; NF non-finite; NUM number; PER person; PRS present; PST past; PTCP participle; S stem; SUB subjunctive; T tense; TV thematic vowel.

Table of contents

1. Introduction
2. Basics of Spanish verbal inflection: Inflectional classes
 - 2.1. The paradigm of regular verbs of Class I
 - 2.2. The paradigm of regular verbs of Class II
3. Inflectional deviations: stem classes and stem alternation patterns
 - 3.1. Stem alternation pattern 1
 - 3.2. Stem alternation pattern 2
 - 3.3. Stem alternation pattern 3
 - 3.4. Stem alternation pattern 4
 - 3.5. Stem alternation pattern 5
 - 3.6. A typology of deviations involving stem alternation patterns
4. Calculating the inflectional complexity of Spanish verbs

- 4.1. Measuring the deviation of P1 and P2
- 4.2. Measuring the deviation of P3-P5
5. Reducing the inflectional complexity of Spanish verbs
6. Concluding remarks

1. Introduction¹

Greville G. Corbett has taught us to look at the physics and topology of morphosyntax. From his work, we have learned possible ways of how to deal with linguistic organization by way of network morphology and of how to deal with linguistic diversity -internal or external- by way of canonical typology. Like many scholars that have crossed his path, I have learned from Grev many things. Four of them are relevant for this work. I learned to appreciate the wonder of morphological splits in paradigms. I learned that zero morphemes should not be dismissed, but they should not always be represented with mathematical zeros, because mathematical zeros give the wrong message about the morphosyntactic mapping between form and meaning, and they distract us from observing the different jobs bare stems can do by themselves. I also learned that being able to explain the distribution of a morphological phenomenon in phonological terms is often and unfairly misinterpreted as being explained by the phonology. And finally, I learned that regardless of where you may end up putting it in your explanation, all information that is required to account for a given morphological phenomenon needs to be stored somewhere in your representation of the lexeme, and it always counts.

This paper is about the inflection of Spanish verbs and it has two goals. On the one hand, I want to present a comprehensive overview of Spanish verbal inflection by means of a novel description which has the benefit of combining the strengths of two different approaches, the traditional approach in Alcoba (1999) and more innovative stem-based approach in Boyé & Cabredo (2006), which is in turn based on Bonami & Boyé (2002, 2003). This is the purpose of section 2. This description makes essential reference to the morphomic patterns involving stem alternations signalled in Maiden (1992, 2009, 2016). The different patterns are discussed in scattered ways in the morphological literature. This is because most authors assume that readers will or should know the essentials of Spanish verbal inflectional morphology, based on the fact that Spanish is one of most widely spoken languages in the world. However, I think it is still convenient to have all patterns presented and discussed in only one place. This is attempted in section 3. The specific way I deal with the structure of such patterns in this paper is based on the specific model I propose for regular inflection.

In this connection, stem alternation patterns are deviations from the inflection of regular verbs. The second goal of the paper proposes a way of measuring how lexemes compare to each other regarding their inflection,² and it aims to tackle how to deal with such inflectional deviations. This is achieved in Section 4. My proposal is based on a defaults-based framework like Network Morphology by Brown and Hippisley (2012), where deviations are seen as default overrides where each override adds an additional element to the set of rules, giving a concrete measure of irregularity. In this light, processing the inflection of a deviating verb is judged to be more costly for the system than processing a default pattern.³ In the paper, I first use a model of complexity *à la* Kolmogorov, according

¹ This paper was written under the auspices of the 2105-2017 CNRS research project *PICS* “Mesoamerica and the syntax of the relative clause”. I want to thank Matthew Baerman and Oliver Bond for inviting me to participate in this special volume. I also want to thank the editors in their role as reviewers because their comments and constructive criticism helped enormously to improve the quality of the paper. I am very grateful to Anna Thornton for all her wise comments and suggestions.

² The second goal is further inspired by the analyses on the verbal inflection of other Romance languages like Italian and French in terms of macro- and microclasses in Dressler and Thornton (1991) and Dressler *et al.* (2003).

³ This is in accordance with a model of complexity *à la* Kolmogorov, according to which a structure is less complex than another if it can be described with a shorter description.

Infl. class	Total	%
I	3104	84%
II	594	16%
Other	2 (0.05%)	
Total	3700	100%

Table 1. Inflectional classes in the sample

Table 1 shows that Class I is by far the one with the largest number of verbs in Spanish. It is also the only productive class. The two verbs characterized as ‘other’ are the verbs IR ‘go’ and SER ‘be’ which have stem suppletion patterns that are not attested in the inflection of any other verb and which make it difficult to characterize them as members of the two main classes.⁷

2.1. The paradigm of regular verbs of Class I

Verbs in Standard Peninsular Spanish inflect in six person/number values, three moods (indicative, subjunctive and imperative) and various tense/aspects (present, imperfect, past, future and conditional). The regular or exemplary verb of Class I uses four stems. First we have a basic stem that is the lexical representation of the lexeme (i.e. how it is stored phonologically in the lexicon). This stem consists of a bound root /bend-/ plus the final vowel /a#/, which in traditional approaches serves as a thematic vowel. This stem also has the broader distribution. The other three stems are ‘inflectional’:⁸ one of such stems is used to build the present subjunctive; a second one is used to build the imperfect indicative; and a third one to build the past participle. All three such inflectional stems are built by means of simple phonological rules that involve replacing the final vowel of the basic stem with specific and invariant stem building material. The paradigm of a regular verb of Class I appears in Table 2, exemplified with verb VENDAR ‘bandage’.

	Stem level	TAM/ NF	PER/ NUM	Stress pattern	Forms
INF	benda Xa ^{LEX}	-r		(...)CV ¹ C ^Σ V(...)	II /bendár/ <i>vendar</i>

AROMATIZAR ‘aromatize’ /aromatia#/ (300); and /Xea#/ APALEAR ‘club’ /apalea#/ (629). This left us with a sample of 3787 verbs, which I admit still includes non-basic verbs. To round it up to 3700, I have cleansed the sample of other 87 verbs that were either defective (I pay no heed to defectiveness as a deviation in this paper) or were not part of my mental lexicon (at least at the time of cleaning the corpus...), e.g. *himpár* ‘have hiccups’ (a variant of *hipar*), *hirmar* ‘set firmly’, *hozar* ‘for a pig to remove ground with the root’, *vahar* ‘give off fumes or steam’ (a variant of *vahear*, itself not very frequent either), *hispir* ‘bristle’ (a synonym of *erizarse*, *esponjarse*), etc. I strongly believe that it will be the same for most readers. After rounding up the corpus to 3700 verbs, I have to exclude the verbs IR ‘go’ and SER ‘be’ from this analysis, because they are very irregular. The sample thus consists of 3698 verbs.

⁷ I have decided to leave them out of the analysis, because they stand out and by themselves from the rest of all verbs. All in all, besides a stem which could be treated as their basic one (i.e. the one used for the infinitive, imperative, future and conditional), these verbs could be said to have a variety of stem alternation patterns (P2, P3 and P4, treated in section 3 below). Such patterns would account for at least three of their different stems. The verbs have one stem for the gerund; one for the present indicative; and another one for the imperfect indicative. In addition, IR ‘go’ has a suppletive stem for the imperative singular, while SER ‘be’ has two more extra stems: one for the 2SG and another for the 3SG of the present indicative. In total, SER ‘be’ has nine different stems, while IR ‘go’ has eight. The paradigm of the two verbs is given in Table I in the Appendix.

⁸ I use the term ‘inflectional stem’ for a stem that replaces the lexical base stem in specific portions or cells in the paradigm, regardless of whether the portion they occur in results into a motivated or a non-motivated split (i.e. morphomic) (Corbett, 2015). In the regular case, an inflectional stem is derived from the lexical stem by a specific set of phonological rules. In other cases, it is listed.

IMP	2SG	benda		—	(...) ¹ CVC ^Σ V(...)	I	/bénda/	<i>venda</i>	
	2PL	benda		-d ⁹	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendád/	<i>vendad</i>	
PRS.IND	1SG	bend(a)		-o	(...) ¹ CVC ^Σ V(...)	I	/béndo/	<i>vendo</i>	
	2SG	benda		-s	(...) ¹ CVC ^Σ V(...)	I	/béndas/	<i>ventas</i>	
	3SG	benda		—	(...) ¹ CVC ^Σ V(...)	I	/bénda/	<i>venda</i>	
	1PL	benda		-mos	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendámos/	<i>vendamos</i>	
	2PL	benda		-is	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendáis/	<i>vendáis</i>	
	3PL	benda		-n	(...) ¹ CVC ^Σ V(...)	I	/béndan/	<i>vendan</i>	
FUT.IND	1SG	benda		-re	—	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendaré/	<i>vendaré</i>
	2SG	benda		-ra	-s	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendarás/	<i>vendarás</i>
	3SG	benda		-ra	—	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendará/	<i>vendará</i>
	1PL	benda		-re	-mos	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendarémos/	<i>vendaremos</i>
	2PL	benda		-re	-is	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendaréis/	<i>vendaréis</i>
	3PL	benda		-ra	-n	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendarán/	<i>vendarán</i>
COND.IND	1SG	benda		-ria	—	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendaría/	<i>vendaría</i>
	2SG	benda		-ria	-s	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendarías/	<i>vendarías</i>
	3SG	benda		-ria	—	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendaría/	<i>vendaría</i>
	1PL	benda		-ria	-mos	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendaríamos/	<i>vendaríamos</i>
	2PL	benda		-ria	-is	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendaríais/	<i>vendaríais</i>
	3PL	benda		-ria	-n	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendarían/	<i>vendarían</i>
PST.IND	1SG	bend(a)		-e	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendé/	<i>vendé</i>	
	2SG	benda		-ste	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendáste/	<i>vendáste</i>	
	3SG	bend(a)		-o	(...) ¹ CVC ^Σ V- ¹ Aff(...)	III	/bendó/	<i>vendó</i>	
	1PL	benda		-mos	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendámos/	<i>vendamos</i>	
	2PL	benda		-steis	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendásteis/	<i>vendasteis</i>	
	3PL	benda		-ron	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendáron/	<i>vendaron</i>	
IMPF.SUB	1SG	benda		-ra ¹⁰	—	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendára/	<i>vendara</i>
	2SG	benda		-ra	-s	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendáras/	<i>vendaras</i>
	3SG	benda		-ra	—	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendára/	<i>vendara</i>
	1PL	benda		-ra	-mos	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendáramos/	<i>vendaramos</i>
	2PL	benda		-ra	-is	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendárais/	<i>vendarais</i>
	3PL	benda		-ra	-n	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendáran/	<i>vendaran</i>
GER		benda		-ndo	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendándo/	<i>vendando</i>	
PRS.SUB	1SG	bende	Xa ^{LEX} →Xe	—	(...) ¹ CVC ^Σ V(...)	I	/bénde/	<i>vende</i>	
	2SG	bende		-s	(...) ¹ CVC ^Σ V(...)	I	/béndes/	<i>ventas</i>	
	3SG	bende		—	(...) ¹ CVC ^Σ V(...)	I	/bénde/	<i>vende</i>	
	1PL	bende		-mos	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendémos/	<i>vendemos</i>	
	2PL	bende		-is	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendéis/	<i>vendeis</i>	
	3PL	bende		-n	(...) ¹ CVC ^Σ V(...)	I	/bénden/	<i>venden</i>	
IMPF.IND	1SG	bendaba	Xa ^{LEX} →Xaba	—	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendába/	<i>vendaba</i>	
	2SG	bendaba		-s	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendábas/	<i>vendabas</i>	
	3SG	bendaba		—	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendába/	<i>vendaba</i>	
	1PL	bendaba		-mos	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendábamos/	<i>vendábamos</i>	
	2PL	bendaba		-is	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendábais/	<i>vendábais</i>	
	3PL	bendaba		-n	(...) ¹ CV ¹ C ^Σ V(...)	II	/bendában/	<i>vendaban</i>	

⁹ For most speakers of Peninsular Spanish the realization of this cell involves the suffix *-r* instead of *-d* (the resulting form is homophonous with the infinitive). For such speakers, the form with *-d* is a learned one.

¹⁰ This subparadigm can also be realized by the suffix *-se* in a well-known case of overabundance treated in Thornton (2011a/b) and pointed out in Stump (2016: 151).

PST.PTCP	bendado	Xa ^{LEX} →Xado ¹¹	—	(...)CV ¹ C ^Σ V(...)	II	/bendádo/	<i>vendado</i>
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Table 2. The paradigm of a basic verb of Class I (stem class /a#/)

Besides inflectional stems, some subparadigms still require further TAM affixation such as the future indicative, conditional indicative and imperfective subjunctive. In my analysis, the sets of suffixes to realize person/number of subject is reduced to two: a default one with the broader distribution (in blue) and another one that is only used for the past indicative. The only cell that involves a morphophonological adjustment is the 1SG present indicative, which in my analysis involves the suffix *-o* (homophonous with the *-o* that realizes 3SG past indicative). A phonological rule avoiding diphthongization in an unstressed syllable prompts the deletion of the stem's final vowel /a/ in contact with a vocalic suffix, e.g. **béndao*→*béndo*. This takes us to stress patterns.

Stress patterns operate regularly and they apply to all verbs regardless of inflectional class. In my approach, there are three main patterns:¹² A rhyzotonic pattern that I treat as 'pattern I' /(...)CVC^ΣV(...)/; a pattern II that has stress over the syllable of the thematic vowel /(...)CV¹C^ΣV(...)/; and pattern III that has stress specified over the suffix /(...)CVC^ΣV-'Aff(...)/.¹³ The distribution of stress patterns is commonly distributed by subparadigm, but there are two morphomic exceptions: one involves the split of 1PL and 2PL forms from the rest of the person values in the present tenses (O'Neill, 2014); and another the split of 1SG and 3SG from the rest of the person values in the past indicative.¹⁴

2.2. The paradigm of regular verbs of Class II

Regular verbs of Class II (those with stems in /e#/ and /i#/) differ from Class I verbs in two main ways: one way involves stem building; the other a difference in exponence. The stem building rules for inflectional stems are different than Class I verbs. This is shown in (a) in Table 3. Additionally, Class II verbs further require two more stems. This is shown in (b). The stem zone for these two extra stems is morphomic because one stem is used for the past indicative for all persons except the 3PL, and the other is used for the gerund, the imperfect subjunctive, and the 3PL of the past indicative. Nevertheless, the rules that apply to build such stems are simple and regular; the only twist being that the stem /XV^{LEX}→Xi/ for verbs of stem class /i#/ is homophonous with the lexical stem.

		Class I		Class II	
		VENDAR 'bandage'		VENDER 'sell'	VIVIR 'live'
(a)		Xa ^{LEX}	benda	Xe ^{LEX} /Xi ^{LEX}	bende bibi
	PRS.SUB	Xa ^{LEX} →Xe	bende	Xe ^{LEX} →Xa	benda biba
	IMPF.IND	Xa ^{LEX} →Xaba	bendaba	Xe ^{LEX} →Xja	bendia bibia
	PST.PTCP	Xa ^{LEX} →Xado	bendado	Xe ^{LEX} →Xido	bendido bibido
(b)	PST.IND	1SG	Xa ^{LEX}	Xe ^{LEX} →Xi	bendi bibi
		2SG	benda		bendi bibi
		3SG	benda		bendi bibi
		1PL	benda		bendi bibi
		2PL	benda		bendi bibi
		3PL	benda	Xe ^{LEX} →Xje	bendie bibie

¹¹ Speakers may also have participles ending in diphthongs /ao/ and /io/. This phenomenon is often talked about as a "the loss of intervocalic /d/", which has a complex distribution (for details see Estrada Arráez, 2012).

¹² For a more specialized account of stress, see Harris (1987).

¹³ The notation CVC^ΣV represents an idealization of a stem shape, where ^ΣV corresponds to the thematic vowel and V to the root vowel. 'Aff' indicates suffixed material that is specified for stress; (...) refers to any phonological material inert to stress rules.

¹⁴ The two cells are also given the same realization by means of a bare stem in many of the subparadigms.

IMPF.SUB	1SG	benda	bendie	bibie
	2SG	benda	bendie	bibie
	3SG	benda	bendie	bibie
	1PL	benda	bendie	bibie
	2PL	benda	bendie	bibie
	3PL	benda	bendie	bibie
GER		benda	bendie	bibie

Table 3. Paradigm comparison between Class I and Class II

As for rules of exponence, Class I and Class II verbs contrast in only one cell: the 1SG past indicative. While verbs of Class I have the overt exponent *-e* for 1SG past (e.g. VNDAR ‘bandage’ has *vendé* /*bend(a)-é*/), verbs of Class II use a bare stem (e.g. VENDER ‘sell’ has *vendí* /*bendí*/ and VIVIR ‘live’ has *viví* /*bibí*/).¹⁵ A full paradigm of verbs of Class II is given in Tables II and III, in the appendix.

Finally, verbs of Class II with stems in /i#/ display the rhyzotonic forms in (b) in Table 4 (with a final /e/) instead of the expected forms in (a) (with a final /i/).

PRS.IND				(a)	(b)	
VENDER ‘sell’	1SG	bend(e)	-o	I	/béndo/	<i>vendo</i> (...) ¹ CVC ² V(...)
	2SG	bende	-s	I	/béndes/	<i>vendes</i> (...) ¹ CVC ² V(...)
	3SG	bende	—	I	/bénde/	<i>vende</i> (...) ¹ CVC ² V(...)
	1PL	bende	-mos	II	/bendémos/	<i>vendemos</i> (...) ¹ CV ¹ C ² V(...)
	2PL	bende	-is	II	/bendéis/	<i>vendeis</i> (...) ¹ CV ¹ C ² V(...)
	3PL	bende	-n	I	/bénden/	<i>venden</i> (...) ¹ CVC ² V(...)
VIVIR ‘live’	1SG	bib(i)	-o	I	/bíbo/	<i>vivo</i> (...) ¹ ICVCΣV(...)
	2SG	bibi	-s	I	*/bíbis/	/bíbes/ <i>vives</i> (...) ¹ ICVCΣi(...)→(...) ¹ ICVCΣe(...)
	3SG	bibi	—	I	*/bíbi/	/bíbe/ <i>vive</i> (...) ¹ ICVCΣi(...)→(...) ¹ ICVCΣe(...)
	1PL	bibi	-mos	II	/bibímos/	<i>vivimos</i> (...) ¹ CV ¹ ICΣV(...)
	2PL	bibi	-is	II	/bibís/	<i>vivis</i> (...) ¹ CV ¹ ICΣV(...)
	3PL	bibi	-n	I	*/bíbin/	/bíben/ <i>viven</i> (...) ¹ ICVCΣi(...)→(...) ¹ ICVCΣe(...)

Table 4. Stress rules for Class II

There are different ways in which the data in (b) in Table 4 can be accounted for. One possible way is to interpret that the contrast is one involving a contrast in exponence. This would make verbs with a stem in /i#/ stand out as a different inflectional class from verbs with a stem in /e#/. In my analysis, however, I prefer to explain the contrast as resulting from the phonological rule in (7), which involves an adjustment in the phonotactic nature of the word form. The adjustment is prompted by a constraint that would disallow having an unstressed syllable with an /i/ in coda position in Spanish.

$$(7) \quad (\dots)^1\text{CVC}\Sigma\mathbf{i}(\mathbf{C})\# \rightarrow (\dots)^1\text{CVC}\Sigma\mathbf{e}(\mathbf{C})\#$$

The rule in (7) has generalized scope in Spanish phonology. Except for loanwords,¹⁶ no word in Spanish has an unstressed /i/ or /iC/ in coda position.¹⁷ In this light, forms such as

¹⁵ Alternatively, Harris (1987) treats the difference of exponence as involving *-e* vs. *-i* with a similar result. In my proposal, the distribution of the allomorphy is predicted from the phonological shape of the stem in question (i.e. the final /i/ of the special stem of classes /Xe#/ and /Xi#/ triggers zero, while the final /a/ of verbs of class /Xa#/ triggers the selection of *-e*).

¹⁶ Anna Thornton has called my attention to the loanword *kiwi* /kígwi/ as an exception to this rule. Another exception would be the loanword *mini* /míni/ designating a BMC economy car.

vive, vives, and viven could be explained as being surface realizations of underlying forms /bíbi/, /bíbis/ and /bíbin/.¹⁸

In this section, I have presented the paradigm types in the inflection of Spanish verbs that have the simplest array of inflectional rules. Other verbs have a different inflectional behaviour from the regular ones. I call such verbs deviating verbs (OBS. I restrict the term ‘irregular verb’ to idiosyncratic verbs). I present such verbs in the following section.

3. Inflectional deviations: stem classes and stem alternation patterns

A considerable number of verbs in Spanish deviate in their inflection from the exemplary paradigms presented in the previous section. The greater type of inflectional deviation we observe is based on stem alternation patterns.¹⁹ Stem alternation patterns are patterns that involve an alternating stem (different from the lexical and the inflectional stems that I have presented so far) that occurs in an array of cells in the paradigm. This array of cells is treated as a pattern. In the sense of Aronoff (1994), all patterns are morphomic because the array of cells where the alternating stem is found does not form a natural class, making the distribution of the alternating stem not accountable in neither morphosyntactic or morphosemantic terms.²⁰ A great deal of the distribution of the patterns is more linked to the phonological aspects of the stems than to the inflectional class of verbs. This suggests that an account of the distribution of stem patterns that appeals to stem classes is more effective. In this light, and following a traditional account I propose that there are three stems classes,²¹ which I refer to as stem class /a#/, stem class /e#/ and stem class /i#/.²² Table 5 shows the overall deviating behaviour of verbs involving stem alternation patterns.

Stem class	(a)		(b)			
	Reg.	Dev.	Reg.	Dev.		
/a#/	3104	84%	3077	91%	27	8%

¹⁷ In contrast, apart from monosyllables such as *si* ‘if’, *sí* ‘yes’ or *ni* ‘nor’, which are out of the equation for being monosyllables, there are a sizeable number of words in Spanish with stressed /i/ in coda, such as *alheli* ‘wallflower’, *frenesí* ‘frenzy’, *jabalí* ‘boar’, etc. or adjectives such as *magrebi* ‘Maghrebi’, *israelí* ‘Israeli’, etc.

¹⁸ The same applies to the form for the 2SG imperative, which is homophonous to the 3SG present indicative.

¹⁹ Other deviations involve only one cell. The cells in questions may involve the form for the 1st person indicative present, the past participle and the imperative. Two verbs require a suppletive stem for the 1SG present indicative, e.g. SABER ‘know’ has *se* instead of **sépo* */*sép(a)-o*/, which would be the expected form from P3; and HABER ‘AUX’ has *he* (instead of **hay-o*). The latter verb also has *he-mos* for 1PL, instead of the expected **habe-mos*. The form *habemos* exists in Latin-American Spanish as an inflected form of the verb HABER but in its restricted use as an existential verb, like in *habemos muchos de nosotros que...* ‘There are many of us who...’ (the paraphrase for such an expression in Peninsular Spanish would need an impersonal form, e.g., *hay muchos de nosotros que...*). Verbs with a monosyllabic form for the 1SG present indicative have the exponent /-oj/ <oy> instead of /-o/, e.g. DAR ‘give’ with basic stem /da#/, would have the form **d(a)-o* → **do*, but instead we have *dói* <doy>. The alternant /-oj/ is provided by the morphology, but its distribution is phonologically conditioned. Furthermore, 30 verbs of Class II have a suppletive stem for the past participle (i.e. PONER ‘put’, PST.PTCP **ponido* → *puesto*; MORIR ‘die’, PST.PTCP **morido* → *muerto*; etc.); and 45 verbs of Class II have a shortened form for the imperative singular (i.e. PONER ‘put’, IMP **pone* → *pon*). The verbs DECIR ‘say’ and IR ‘go’ have the suppletive forms *di* and *ve*.

²⁰ In a more recent typology of morphemes in Round (2015), the structures would qualify as ‘metamorphomes’.

²¹ These stem classes can already be seen at work in Class II. In the previous section, we have seen that verbs of Class II show a slightly different behaviour depending on what the shape of their lexical stem is. In other words, while the inflectional behaviour of all such verbs could be treated in a unified way as forming one inflectional class, verbs whose lexical stems end in /i#/ have different surface outcomes than those whose lexical stems end in /e#/.

²² In reality, the split into stem classes only really makes sense for verbs of Class II, because all verbs of Class I belong to stem class /a#/ and vice versa.

/e#/	271	7%	84	2.5%	187	58%
/i#/	323	9%	212	6.5%	111	34%
Total	3698	100%	3373	100%	325	100%

Table 5. Basic and deviating verbs per stem class

Table 5 provides two views of inflectional deviation: (a) is a view across stem classes and (b) separates regular verbs from deviating verbs across the classes. The figures in (b) show that verbs of stem class /a#/ are very regular (i.e., 91% of basic verbs are found in stem class /a#/), while 92% of deviating verbs belong to stem classes /e#/ (58%) and /i#/ (34%). But verbs of stem class /e#/ are significantly more prone to deviation than verbs of stem class /i#/ even though, as indicated in (a), the sample has an almost equal share of verbs from both classes.²³

In the remainder of this section, I introduce the five different stem alternation patterns that account for such deviations.

3.1. Stem alternation pattern 1

Some verbs in Spanish (165 in my sample) display a stem alternation pattern that in the literature has been referred to as the morphomic ‘N-pattern’ (Maiden, 2005) and which I treat here as ‘pattern 1’ (henceforth, P1). P1 involves an alternating stem in the present subparadigms (indicative and subjunctive) and the singular imperative (which is based on the indicative). The pattern feeds an alternating stem to the stem spaces already provided by the suprasegmental morphomic pattern based on rhyzotonic cells (see last paragraph of section 2.1). P1 is phonologically restricted to verbs with roots in /e/, /i/ and /o/. The alternating stem is produced by the apophony of the root vowel with predictable outcomes: /i→je/ (e.g. ADQUIRIR ‘acquire’ /adkiri, adkjeri/) and /o→we/ (e.g. MORIR ‘die’ /mori, mweri/).

However, verbs with roots in /e/ of stem class /i#/ split into two classes. This can be seen in the shape of the alternating stem: Class A involves the rule /e→je/ (e.g. MENTIR ‘lie’ /menti, mjenti/) and Class B has the rule /e→i/ (e.g. PEDIR ‘ask for’ /pedi, pidi/). The membership of these two classes is lexical.²⁴ Examples of both appear in Table 7, where cells affected by the pattern are given in green.

		Class A	Class B
		MENTIR ‘lie’	PEDIR ‘ask for’
IMP	2SG	miénte	píde
	2PL	mentí-d	pedí-d
PRS.IND	1SG	miént-o	píd-o

²³ The sample is representative of the Spanish lexicon because the vast majority of existing verbs belonging to classes /e#/ and /i#/ are included in the sample.

²⁴ However, the alternating stem with a mutated root in /je/ and /we/ is very informative as a cue for P1. There are only a few verbs that carry a root in /je/ and /we/ in their basic stem, and none belong to stem classes /e#/ or /i#/. This means that encountering these diphthongs in inflected forms of verbs of these stem classes indicates that the verb in question has P1.

	2SG	miénte-s	píde-s
	3SG	miénte	píde
	1PL	mentí-mos	pedí-mos
	2PL	mentí-(i)s	pedí-(i)s
	3PL	miénte-n	píde-n
PRS.SUB	1SG	miénta	pída
	2SG	miénta-s	pída-s
	3SG	miénta	pída
	1PL	mintá-mos	pidá-mos
	2PL	mintá-is	pidá-is
	3PL	miénta-n	pída-n

Table 6. Verbs with root in /e/ for P1

3.2. Stem alternation pattern 2

In Table 6 in the previous section, we could already see that the forms for the 1PL and 2PL present subjunctive have a root in /i/ instead of the expected /e/. These forms instantiate a second stem alternation pattern that I treat as ‘pattern 2’ (P2). This new pattern is found in 92 verbs in my sample. It is illustrated in Table 7, where cells affected by the pattern are given in red.²⁵ Like P1, P2 also has morphomic structure, but it is only attested in verbs of stem class /i#/ with root vowels in /e/ and /o/. The outcome of the alternating stem involves the root apophony rule /e→i/ and /o→u/. This means that for verbs of Class B, the alternating stem for P2 is incidentally homophonous with the alternating stem of P1. This homophony may give the impression that those verbs instantiate yet a different, larger pattern. I have preferred to analyse the data as displaying two patterns.

		MORIR ‘die’ P1+P2	MENTIR ‘lie’ P1.A+P2	PEDIR ‘ask for’ P1.B+P2
INF		morí-r	mentí-r	pedí-r
IMP	2SG	muére	miénte	píde
	2PL	morí-d	mentí-d	pedí-d
PRS.IND	1SG	muér-o	miént-o	píd-o
	2SG	muére-s	miénte-s	píde-s
	3SG	muére	miénte	píde
	1PL	morí-mos	mentí-mos	pedí-mos
	2PL	morí-(i)s	mentí-(i)s	pedí-(i)s
	3PL	muére-n	miénte-n	píde-n
	PST.IND	1SG	morí	mentí
2SG		morí-ste	mentí-ste	pedí-ste
3SG		muri-ó	minti-ó	pidi-ó
1PL		morí-mos	mentí-mos	pedí-mos
2PL		morí-steis	mentí-steis	pedí-steis
3PL		murié-ron	mintié-ron	pidié-ron
IMPF.SUB	1SG	murié-ra	mintié-ra	pidié-ra
	2SG	murié-ras	mintié-ras	pidié-ras
	3SG	murié-ra	mintié-ra	pidié-ra
	1PL	murié-ramos	mintié-ramos	pidié-ramos
	2PL	murié-raís	mintié-raís	pidié-raís
	3PL	murié-ran	mintié-ran	pidié-ran
GER		murié-ndo	mintié-ndo	pidié-ndo
PRS.SUB	1SG	muéra	miénta	pída
	2SG	muéra-s	miénta-s	pída-s
	3SG	muéra	miénta	pída
	1PL	murá-mos	mintá-mos	pidá-mos
	2PL	murá-is	mintá-is	pidá-is

²⁵ Areas of the paradigm that remain untouched by P2 are the imperfective indicative, the future, the conditional, plus the past participle and the infinitive.

3PL	muéra-n	miénta-n	pída-n
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Table 7. P1 and P2

3.3. Stem alternation pattern 3

Verbs in Spanish (182 in my sample) may display another stem alternation pattern that has been referred to in the literature as the ‘L-pattern’ (Maiden, 2005; Bermúdez-Otero & Luís, 2016), whose modern productivity is discussed in Nevins *et al.* (2015). I treat such pattern as ‘pattern 3’ (P3). The pattern affects the cells of the present subjunctive and the cell for the 1SG present indicative. The shape of the alternating stem can be predicted if the basic stem involves a shape such as /XV(C_{SONORANT})θV#/ or /XVnV#/, in which case it is /XV(C_{SONORANT})θkV#/ and /XVnV#/, respectively, unless specified. In other cases, the outcome is listed. This alternation type is illustrated in Table 8, which shows cases where P3 (in blue) operates alone or in overlap with P1 (in green). In the latter case, P3 is superimposed on P1.

		Stem class /e#/		Stem class /i#/
		PADECER ‘suffer from’ P3	TENER ‘have’ P1.A + P3	DECIR ‘say’ P1.B + P3
PRS.IND	1SG	padéθk-o	téng-o	díg-o
	2SG	padéθe-s	tiéne-s	díθe-s
	3SG	padéθe	tiéne	díθe
	1PL	padeθé-mos	tené-mos	deθí-mos
	2PL	padeθé-is	tené-is	deθí-(i)s
	3PL	padéθe-n	tiéne-n	díθe-n
PRS.SUB	1SG	padéθka	ténga	díga
	2SG	padéθka-s	ténga-s	díga-s
	3SG	padéθka	ténga	díga
	1PL	padeθká-mos	tengá-mos	digá-mos
	2PL	padeθká-is	tengá-is	digá-is
	3PL	padéθka-n	ténga-n	díga-n

Table 8. P3

3.4. Stem alternation pattern 4

Another stem alternation pattern found in 66 verbs in my sample is pattern 4 (P4). This pattern involves an alternating stem in the past indicative and the imperfect subjunctive. Except for the gerund, the alternating stem operates in the stem zone where simple verbs of Class II have the two extra stems when compared to the verbs of Class I (see section 2.2).²⁶ The lexical root of the alternating stem is not predictable by rule and needs to be listed. The pattern does not only involve root suppletion, but also its own stress pattern set. More specifically, it cancels the requirement of stress pattern III (/(...CVC²V-¹Aff(...)/) for the cells of the 1SG and the 3SG of the past indicative. Instead, it requires rhyzotonic pattern II (/(...CV¹C²V(...)/) (OBS. the form for 1SG further undergoes the phonological adjustment in (7) that involves *i* → *e*). The pattern is illustrated in Table 9 with cells in violet. The occurrence of P4 is linked to P3; that is the reason why I have also included P3 in the table.

		TRAER ‘bring’ P3 + P4			
PST.IND	1SG	*traxí	→ *tráxi	→ tráxe	traje
	2SG	traxí-ste			trajiste

²⁶ This can be taken as evidence that the gerund forms a stem zone by itself. Further evidence for this comes from the fact that irregular verbs SER ‘be’ and IR ‘go’ have an irregular gerund that is based on P1.A (*sie-ndo* and *ye-ndo*).

	3SG	*trax-ó	→	tráx-o	<i>trajo</i>
	1PL	traxí-mos			<i>trajimos</i>
	2PL	traxí-steis			<i>trajisteis</i>
	3PL	*traxjé-ron	→	traxé-ron ²⁷	<i>trajeron</i>
IMPF.SUB	1SG	traxé-ra			<i>trajera</i>
	2SG	traxé-ras			<i>trajeras</i>
	3SG	traxé-ra			<i>trajera</i>
	1PL	traxé-ramos			<i>trajeramos</i>
	2PL	traxé-raís			<i>trajerais</i>
	3PL	traxé-ran			<i>trajeran</i>
PRS.IND	1SG	traíg-o			<i>traigo</i>
	2SG	traé-s			<i>traes</i>
	3SG	traé			<i>trae</i>
	1PL	traé-mos			<i>traemos</i>
	2PL	traé-is			<i>traeis</i>
	3PL	traé-n			<i>traen</i>
PRS.SUBJ	1SG	traíga			<i>traiga</i>
	2SG	traíga-s			<i>traigas</i>
	3SG	traíga			<i>traiga</i>
	1PL	traigá-mos			<i>traigamos</i>
	2PL	traigá-is			<i>traigais</i>
	3PL	traíga-n			<i>traigan</i>

Table 9. P3 and P4

3.5. Stem alternation pattern 5

Finally, pattern 5 (P5) is attested by the verb DECIR ‘say’. It affects the stem used to build the future and the conditional: instead of lexical /deθi/, the verb has the suppletive stem /di/, e.g. 1SG future /di-ré/ instead of */deθi-ré/ (see Table 11 below for a detailed illustration).

3.6. A typology of deviations involving stem alternation patterns

In the previous sections, we have seen that verbs can have up to five different stem alternation patterns. We have also seen that some verbs may have more than one pattern. The way the patterns are instantiated results into nine types of possible combinations. The relevant data, based on the same figures as Table 5 above, are presented in Table 10. Here the letter phi (Φ) is used to indicate the occurrence of a given pattern. Letters A and B represent the two classes involved in P1. Verbs that lack a stem alternation pattern are treated as Type 0.

Sample							3104	271	323	3698
Type	P1	P2	P3	P4	P5	/a#/	/e#/	/i#/	Total	
0	—	—	—	—	—	3077	84	212	3373	
1	Φ(A)	—	—	—	—	24	35	2	61	
2	—	—	Φ	—	—	0	115	6	121	
3	—	—	—	Φ	—	3	0	0	3	
4	i Φ(A)	—	Φ	—	—	0	0	39	39	
	ii Φ(B)	Φ	—	—	—	0	0	38	38	
5	—	—	Φ	Φ	—	0	25	11	36	
6	Φ(A)	—	—	Φ	—	0	2	0	2	
7	Φ(A)	—	Φ	Φ	—	0	10	0	10	

²⁷ The expected stem would be /traxje/ instead of /traxe/, but speakers of the Standard do not allow for the cluster [xje], while the stem /traxje/ is known to exist in substandard varieties.

8	Φ(A)		Φ	Φ	Φ	—	0	0	11	11
9		Φ(B)	Φ	Φ	Φ	Φ	0	0	4	4
	120	45								
Total	165	92	182	66	4	27	187	111	325	

Table 10. Combinations of stem alternation patterns in types

The nine different types of combinations in Table 10 give us an insight as how inflectional deviations work in the inflectional system of Spanish:

- Types 1-3 involve verbs that display only one stem alternation pattern, i.e. verbs with such types have only pattern of deviation. The rest of the types involve more than one pattern.
- The distribution of the patterns is not balanced across stem classes: 92% of stem alternation patterns are found in stem classes /e#/ (187) and /i#/ (111).
- Also, the degree of expectation for the occurrence of a stem alternation pattern differs dramatically from verbs of stem class /a#/ to verbs of stem class /e#/: only 1% of verbs of stem class /a#/ have a stem alternation pattern, while 70% of stem class /e#/ have it. The expectation for verbs of stem class /i#/ is more balanced: 35% of them have such patterns.
- Stem classes /e#/ and /i#/ have stem alternation patterns, but the expectation is very different as to the way they display such patterns: 80% of deviating verbs of stem class /e#/ have only one pattern (Type 1 with P1.A and Type 2 with P3), while 93% of deviating verbs of stem class /i#/ have more than one pattern (Types 4, 5, 8 and 9).

Type 9 represents a case of a paradigm which is rich in stem alternation patterns and it deserves our attention because it also shows a case of levelling that uncovers the subjacent presence of other patterns. The type is attested by the verb DECIR ‘say’, as illustrated in Table 11 below.

The verb DECIR ‘say’ forms part of a family of lexemes that share the same stem /(X)deθi#/: DES+DECIR=SE ‘retract’; CONTRA+DECIR ‘contradict’; (archaic) ENTRE+DECIR ‘interdict’; BEN+DECIR ‘bless’; MAL+DECIR ‘curse/damn’ and PRE+DECIR ‘foretell’. Families like this are the outcome of historical word formation processes from Latin and further back in time, but for the most part the member lexemes are no longer semantically linked and are learned as independent words (see Spencer 2016). Despite being independent words, in the default case the lexemes in such families happen to share morphological properties associated to their old basic stem, and they show a remarkable consistent inflectional behaviour. Interestingly, the only exception is the /(X)deθi#/ family.

Three of the members of the /(X)deθi#/ family (i.e., BEN+DECIR ‘bless’, MAL+DECIR ‘curse’ and PRE+DECIR ‘predict’) have undergone levelling in a portion of the paradigm. The levelling involves the past participle, the future and the conditional, which as a result are now built attending to the default paradigm. This is shown in Table 11. This in turn means they have done away with a suppletive stem and the morphomic P5.²⁸ The breaking of the inflectional link with DECIR ‘say’ is creating inflectional uncertainty for most speakers elsewhere in the paradigm. This is producing further levelling resulting in overabundance involving the cells of P4. The lifting of P4 reveals the occurrence of P2 over which it was superimposed, and which could only be observed in the gerund. The conservative forms are recommended by

²⁸ See Esher (2013, 2015) for the morphomic behaviour of this pattern in Occitan.

the standard and they are learned; the innovative ones are of common use, but are still judged negatively as improper and unrefined.

		DECIR 'say' /deθi#/'		BENDECIR 'bless' /bendeθi#/'	
PST.PTCP		dícho	≠	ben+díθie-ndo	
FUT	1SG	di-ré	≠	ben+deθi-ré	
	2SG	di-rás	≠	ben+deθi-rás	
	3SG	di-rá	≠	ben+deθi-rá	
	1PL	di-rémos	≠	ben+deθi-rémos	
	2PL	di-réis	≠	ben+deθi-réis	
	3PL	di-rán	≠	ben+deθi-rán	
FUT	1SG	di-ría	≠	ben+deθi-ría	
	2SG	di-rías	≠	ben+deθi-rías	
	3SG	di-ría	≠	ben+deθi-ría	
	1PL	di-ríamos	≠	ben+deθi-ríamos	
	2PL	di-ríais	≠	ben+deθi-ríais	
	3PL	di-rían	≠	ben+deθi-rían	
IMP	2SG	di	≠	ben+diθe	
PRS.IND	1SG	dig(a)-o	=	ben+dig(a)-o	
	2SG	díθe-s	=	ben+díθe-s	
	3SG	díθe	=	ben+díθe	
	1PL	deθí-mos	=	ben+deθi-mos	
	2PL	deθí-(i)s	=	ben+deθi-(i)s	
	3PL	díθe-n	=	ben+díθe-n	
PRS.SUB	1SG	díga	=	ben+díga	
	2SG	díga-s	=	ben+díga-s	
	3SG	díga	=	ben+díga	
	1PL	digá-mos	=	ben+digá-mos	
	2PL	digá-is	=	ben+digá-is	
	3PL	díga-n	=	ben+díga-n	
PST.IND	1SG	díxe	=	ben+díxe	≠ ben+deθí
	2SG	dixí-ste	=	ben+dixí-ste	≠ ben+deθí-ste
	3SG	díx(i)-o	=	ben+díx(i)-o	≠ ben+díθi-ó
	1PL	dixí-mos	=	ben+dixí-mos	≠ ben+deθí-mos
	2PL	dixí-steis	=	ben+dixí-steis	≠ ben+deθí-steis
	3PL	dixé-ran	=	ben+dixé-ran	≠ ben+díθie-ron
IMPF.SUB	1SG	dixé-ra	=	ben+dixé-ra	≠ ben+díθie-ra
	2SG	dixé-ras	=	ben+dixé-ras	≠ ben+díθie-ras
	3SG	dixé-ra	=	ben+dixé-ra	≠ ben+díθie-ra
	1PL	dixé-ramos	=	ben+dixé-ramos	≠ ben+díθie-ramos
	2PL	dixé-raís	=	ben+dixé-raís	≠ ben+díθie-raís
	3PL	dixé-ran	=	ben+dixé-ran	≠ ben+díθie-ran
GER		díθié-ndo	=	ben+díθie-ndo	

Legend

 P1
 P2
 P3
 P4
 P5
 Suppletive cells
 Default

Table 11. The verbs DECIR 'say' and BENDECIR 'bless' compared.

Having presented the main stem alternation patterns in Spanish and their overall distribution, an important question still remains: How can we tackle the weight such patterns have for the inflectional system of Spanish? In the following section, I attempt to provide an answer to such a question.

4. Calculating the inflectional complexity of Spanish verbs

In section 2, I first introduced the two verbal paradigm types in Spanish that have the simplest array of inflectional rules. In the previous section, we have seen that other verbs have other arrays involving stem alternation patterns. I have considered such patterns as

inflectional deviations. My approach to inflectional deviations is inspired by the defaults-based framework of Network Morphology in Brown and Hippisley (2012), where each override of a default adds an additional element to the set of rules, giving a concrete measure of irregularity.²⁹ In other words, an inflectional deviation counts as a default override. To deal with the deviations imposed by stem alternation patterns in a comprehensive way, it is not only desirable to be able to pinpoint where they happen (as in the previous section), but also to be able to say something about how lexemes relate to each other regarding degree of deviation, which in turn would render them in a scale of morphological complexity. But to do that, we first need a way to measure the internal complexity of a system.

In this paper, I propose a simple method to evaluate the inflectional complexity of a given verb with respect to other verbs.³⁰ For this we provide a score for each inflectional dimension that is susceptible of deviation. The basic scores I propose are spelled out in (8), where an increase in inflectional complexity is viewed as an increase in bits of information:³¹

- (8) a. A verb abiding by a default adds 0 bits of information to its inflectional complexity.
 b. A verb overriding a default (i.e., a deviating verb) adds:
- 1 bit when the deviation involves a pattern that is different than the patterns described for the default.
 - 1 bit when the deviation further involves a stem that needs to be listed in the lexicon and cannot be produced from regular morphophonological rules (i.e. it is a suppletive stem).

In a Kolmogorov-style view of complexity,³² stem alternation patterns are deviations that represent an increase in the overall morphological complexity of the system. In such a view, every stem alternation pattern, whatever it is, represents an increase in the degree of complexity of a given verb. Such a view has the following consequences: (i) verbs of Types

²⁹ I do not use here the formal model proposed in Brown and Hippisley (2012).

³⁰ The method is internal to Spanish and is not intended to provide comparable measures of complexity across different systems.

³¹ I adopt here a view on morphological complexity that is based on Baerman *et al.* (2009, 2015), where morphological complexity is seen as a relational concept involving the amounts of morphological information speakers need to deal with in order to be able to inflect a given lexeme.

³² My focus is on morphological complexity. I leave other processes out of the equation such as those that could be seen as operating at a more superficial level by virtue of phonological adjustments. One of such adjustments operates in the future, where /Xn'rVX/ is phonotactically adjusted to /Xnd'rVX/, e.g. VENIR 'come' 1SG.FUT /bendr / *vendr * instead of /benr /. A more complex adjustment affects forms of verbs of stem class /i#/ with a stem shape in /Xui#/, such as CONSTRUIR 'build' /konstrui#/. The adjustments involve the palatalization of /i/ in contact with vocalic suffixes as a result of resyllabification: / a/ and / e/ are rendered as [ ja] and [ je], (a); / io/ as [ jo] (b); / io/ and / ie/ become [uj ] and [uj ], (c); and / ai/ develops an excrement [j] in [uj i] (d). Similarly impossible diphthongs such as / e/ and / e/ are broken as [aj ] and [oj ], as shown in (e) with the verbs TRAER 'bring' and ROER 'gnaw'.

a.	1SG.PRS.SUB	*konstr�a		→	konstr�ja	<i>construya</i>
	2SG.PRS.IND	*konstr�is	→ *konstr�es	→	konstr�jes	<i>construyes</i>
b.	1SG.PRS.IND	*konstr�io		→	konstr�jo	<i>construyo</i>
c.	3SG.PST.IND	*konstr�io		→	konstr�j�	<i>construyo</i>
	1SG.IMP.F.SUB	*konstrui�era		→	konstruj�era	<i>construyera</i>
d.	2PL.PRS.SUB	*konstr�ais		→	konstruj�is	<i>construyais</i>
e.	GER	*tra�endo		→	traj�endo	<i>trayendo</i>
		*ro�endo		→	roj�endo	<i>royendo</i>

1-3 would be equally complex because they would involve the same amount of description (i.e. verb X involves stem alternation pattern Y); (ii) among the deviating verbs, verbs of Types 1-3 would be less complex than verbs of other types because their description would be necessarily shorter (i.e. Types 4-9 involve more patterns, hence longer descriptions); a verb of Type 4 with two stem alternation patterns would necessarily be less complex than one of Type 9 with 5 patterns. Such a view of complexity would render things quite straight-forward. The results are given in Table 12. Here the 325 verbs having a stem alternation pattern would be seen as deviating verbs. According to (8b), the increase in complexity they would display depends on how many patterns they require and whether the shape of the alternating stem in each of the patterns can or cannot be predicted.

		0	+1	+2	+3	+4	+5	+6	+7
/a#/	3104	3077	24	3	—	—	—	—	—
/e#/	271	84	146	4	17	20	11	—	4
/i#/	323	212	6	79	11	—	—	—	—
Total	3698	3373	176	86	28	20	11		4
Deviating									325

Table 12. 1st scoring of the morphological complexity of Spanish verbs

However, under an alternative view of complexity, not all patterns added to a simple paradigm have to be necessarily seen as equally costly if their application can be predicted by the presence of other patterns. In other words, following the proposals of implicational morphology in Ackerman *et al.* (2009); Ackerman & Malouf (2013); Montermini & Bonami (2013); Sims (2010); Bonami & Beniamine (2016), etc., we can also take the predictive power of implicational relations into account. For example, the occurrence of P2 and P5 are dependent on the occurrence of other patterns under specific circumstances (i.e., P2 only occurs in verbs of stem class /i#/ and it is dependent on P1). In this way, it would not suffice to say that verbs having P2 are more complex than verbs having P1, when the presence of P2 is a given for certain verbs having P1. In this light, one can consider cases of minimal entropy according to the principle in (9).

- (9) If all instances of pattern A is predicted from the presence of pattern B, and vice versa (i.e., with 0 entropy), the occurrence of one of the patterns does not add bits to the structural complexity of the lexeme that has both patterns.

This opens the possibility than some patterns are less costly than others. To be able to calculate the general cost to the system we need to establish a series of notebooks of what counts as an inflectional default and what as a default override in the grammar of Spanish for the context of each specific deviation.

4.1. Measuring the deviation of P1 and P2

The distribution of P1 and P2 in the sample is given in Table 9.

	Stem class /a#/			Stem class /e#/			Stem class /i#/				
	P1	P2	None	P1	P2	None	P1		P2	None	
							A	B			
Root in /e/	17	—	573	27	—	156	89	(44)	(45)	89	5
Root in /i/	0	—	848	0	—	0	2			—	70
Root in /o/	7	—	507	20	—	38	3			3	1

Total	24	1928	47	194	92	92	76
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Table 13. Distribution of P1 and P2

Table 13 shows that the distribution of P2, which only occurs with verbs of stem class /i#/, is implicationally linked to the existence of P1. The correlation works both ways making the entropy level very low. I take that the implication bears no impact on the structural complexity of the system, and hence the occurrence of P2 costs nothing for verbs of stem class /i#/. From the distributional properties of the patterns, I propose the defaults notebook in (10). In all such notebooks, defaults cost 0 bits.

(10) Defaults notebook for P1 and P2.

Verbs of stem class /a#/:

- I. The default for a verb of stem class /a#/ is NOT to have P1. This default is based on the observation that P1 only occurs in less than 1% of the sample.
- If this default is overridden, a verb of stem class /a#/ with P1 adds 1 bit to its complexity.

Verbs of stem class /e#/:

- II. The default for a verb of stem class /e#/ is NOT to have P1. This default is based on the observation that P1 only occurs in 20% of verbs with stems in /eCe#/ and /oCe#/.
 - If this default is overridden, the verb adds 1 bit to its complexity.

Verbs of stem class /i#/:

- III. The default for a verb with a root in /e/ (i.e. stem in /XeCi#/) IS to have P1 and to be of Class B. P2 comes for free for such verbs. If this default does not apply, the expectation is that a verb in /XeCi#/ will have P1 and belong to Class A instead.
 - Default overrides add 1 bit to the complexity of the verb.
- IV. The default for a verb with roots in /o/ or /i/ is NOT to have P1 (or 2).
 - If the default is overridden, the verb adds 1 bit to its complexity.

4.2. Measuring the deviation of P3-P5

P3 is restricted to verbs of Class II, i.e. stem classes /e#/ and /i#/. The distribution of P3 is given in Table 14, where the verbs are organized according to stem shape, (C_{SONORANT} involves /l/, /n/, /r/, and more rarely /s/).

	Stem class /e#/			Stem class /i#/		
	Total	+3	-3	Total	+3	-3
/Xe(C_{SONORANT}) θ V#/ /Xo(C_{SONORANT}) θ V#/ /Xa(C_{SONORANT}) θ V#/ /Xu θ V#/ /XenV#/ /XonV#/ Other	103 5 8 0 10 13 132	103 2 8 0 10 13 12	0 3 0 0 0 0 120	7 0 0 15 0 0 301	7 0 0 15 8 0 2	0 0 0 0 1 0 290
Total	271	148	123	323	34	291

Table 14. Distribution of P3 for stem classes /e#/ and /i#/

P3 is common in verbs of stem class /e#/, because half of them have it: 148 out of 271 verbs have it (54%). But the pattern is NOT at all common in stem class /i#/, where only 10% do (32 out of 323). In principle, this uneven distribution could be taken to reveal something about the nature of P3, but in reality the pattern is linked to the phonological profile of the lexical stem. Because of this, I propose the defaults notebook for P3 in (11).

(11) Defaults notebook for P3.

<p>For verbs of stem class /e#/:</p> <p>V. The default for a verb whose lexical stem has one of the following shapes is to have P3:</p> <p style="padding-left: 40px;">/Xe(C_{SONORANT})θe#→Xe(C_{SONORANT})θka#/, e.g. ABORRECER ‘dislike’</p> <p style="padding-left: 40px;">/Xo(C_{SONORANT})θe#→Xo(C_{SONORANT})θka#/, e.g. CONOCER ‘know’</p> <p style="padding-left: 40px;">/Xa(C_{SONORANT})θe#→Xa(C_{SONORANT})θka#/, e.g. NACER ‘be born’</p> <p style="padding-left: 40px;">/Xene#→Xenga#/, e.g. TENER ‘have’</p> <p style="padding-left: 40px;">/Xone#→Xonga#/, e.g. PONER ‘put’</p> <p>For verbs of stem class /i#/:</p> <p>VI. The default for a verb whose lexical stem has one of the following shapes is to have P3:</p> <p style="padding-left: 40px;">/Xeθi#→Xeθka#/, e.g. ABORRECER ‘dislike’</p> <p style="padding-left: 40px;">/Xeni#→Xenga#/, e.g. VENIR ‘come’</p> <p style="padding-left: 40px;">/Xu(C_{SONORANT})θi#→Xu(C_{SONORANT})θka#/, e.g. LUCIR ‘be bright’</p> <p>- Other verbs with P3 add 1 bit extra to their complexity and 1 for the suppletive alternating stem.</p>

The implicational relation between the occurrence of P3 and P4 is shown in Table 15. Here we can see that 95% of the verbs of stem class /e#/ and 100% of all verbs of stem class /i#/ that have P4 also have P3. However, the correlation does not work both ways, because not all verbs with P3 have P4.

	Total	P.3	-P.3	P.4	-P.4	N° of verbs with P.4 that also have P.3	N° of verbs with P.3 that also have P.4
Class /a#/	3104	0	3104	3	3101	0 out of 3	0 out of 3
Class /e#/	271	148	123	37	234	35 out of 37	35 out of 148
Class /i#/	323	32	291	26	297	26 out of 26	26 out of 32
Total	3698	180	3518	66	3632		

Table 15. Correlation between P3 and P4

This correlation helps lower the complexity level of the verbs that require P4. Attending to the distribution of P4 in the sample, I propose the defaults notebook in (12).

(12) Defaults notebook for P4.

<p>For verbs of stem class /a#/:</p> <p>VII. The default for a verb of stem class /a#/ is NOT to have P4.</p> <p>- If this default is overridden, a verb of stem class /a#/ with P4 adds 1 bit to its complexity for the pattern and 1 bit for the suppletive alternating stem.</p>

For verbs of stem class /e#/:

VIII. The default for a verb of stem class /e#/ is NOT to have P4.

- If this default is overridden, the verb adds 1 bit to its complexity for the pattern and 1 for the suppletive alternating stem.

For verbs of stem class /i#/:

IV. The default for a verb of stem class /e#/ IS to have P4 if it has P3. For these verbs, P4 comes for free, but the verbs add 1 for the suppletive alternating stem.

Finally, P5 is only attested by the verb DECIR ‘say’ and other related verbs. Establishing the pattern for such verbs costs 1 bit to each verb, plus 1 bit extra for the suppletive stem they require.

5. Reducing the inflectional complexity of Spanish verbs

In Table 12 above, I attempted a calculation of the morphological complexity of Spanish verbs based on a straight-forward application of a Kolmogorov-style view of complexity. Under such a view, from a sample of 3698 verbs belonging to stem classes /a#/, /e#/ and /i#/, 3363 of them (90%) are the only verbs with zero morphological complexity because they are the ones that do not have stem alternation patterns. The rest, which do, would be more complex depending on the number of stem alternation patterns they have and on how predictable the shape of their alternating stem is.

In contrast to this view, in a more balanced take on complexity based on implicational relations, I have proposed that for a number of deviating verbs, the stem alternation pattern adds 0 bits to their structural complexity under specific circumstances (i.e., under the dictates of default notebooks). The results of applying this alternative view are given in Table 16.

		Basic	Verbs with stem alternation patterns						
		0	+1	+2	+3	+4	+5	+6	+7
/a#/	3104	3077	—	24	3	—	—	—	—
/e#/	271	84	111	35	19	12	10	—	—
/i#/	323	212	42	55	10	4	—	—	—
Total	3698	3373	153	114	32	16			
Total of 0		3526							
Total of deviating verbs							325		

Table 16. 2nd scoring of the morphological complexity of Spanish verbs

This alternative view has the advantage of reducing the overall complexity of the system using the same measures. The ratio of the verbs abiding by an inflectional default increases from 91% to 95%, but more significantly, 47% of deviating verbs are no longer seen as irregular and those that are irregular are regarded as less so. On the other hand, the fact that we can reduce the overall complexity of the system does not necessarily mean that we have to reduce the descriptions, but that the descriptions become a description of another type of inflectional regularity.³³ Exemplar verbs for each possible type of deviation and complexity scores are given in Table 17 from the total of 325 verbs with stem alternations patterns.

³³ The new descriptions in the default notebook still have to be stored somewhere, probably at the space where all morphophonological interface phenomena are stored, where they would burden that space with further complexity.

Ex	Stem alternation patterns						#	Complexity scoring					Total		
	Type	P1	P2	P3	P4	P5		P1	P2	P3	P4	P5			
/a#/	NEGAR	'deny'	1	$\Phi(A)$	—	—	—	—	24	+1	—	—	—	—	+1
	ANDAR	'walk'	3	—	—	—	Φ	—	3	—	—	—	+2	—	+2
27															
/e#/	MOVER	'move'	1	$\Phi(A)$	—	—	—	—	50	+1	—	—	—	—	+1
	VENCER	'win'	2	—	—	Φ	—	—	111	—	—	0	—	—	0
	VALER	'cost'	2	—	—	Φ	—	—	4	—	—	+2	—	—	+2
	CABER	'fit in'	5	—	—	Φ	Φ	—	10	—	—	+2	+2	—	+4
	QUERER	'want'	6	$\Phi(A)$	—	—	Φ	—	2	+1	—	—	+2	—	+3
	TENER	'have'	7	$\Phi(A)$	—	Φ	Φ	—	10	+1	—	0	+2	—	+3
	187														
/i#/	ADQUIRIR	'acquire'	1	$\Phi(A)$	—	—	—	—	2	+1	—	—	—	—	+1
	SALIR	'exit'	2	—	—	Φ	—	—	2	—	—	+2	—	—	+2
	LUCIR	'shine'	2	—	—	Φ	—	—	4	—	—	0	—	—	0
	HERIR	'wound'	4.i	$\Phi(A)$	Φ	—	—	—	39	+1	0	—	—	—	+1
	ELEGIR	'chose'	4.ii	$\Phi(B)$	Φ	—	—	—	38	0	0	—	—	—	0
	TRADUCIR	'translate'	5	—	—	Φ	Φ	—	11	—	—	0	+1	—	+1
	VENIR	'come'	8	$\Phi(A)$	Φ	Φ	Φ	—	8	+1	0	0	+1	—	+2
	BENDECIR	'bless'	8	$\Phi(B)$	Φ	Φ	Φ	—	3	0	0	0	+1	—	+1
	DECIR	'say'	9	$\Phi(B)$	Φ	Φ	Φ	Φ	4	0	0	0	+1	+2	+3
	111														

Table 17. Examples of verbs for inflectional deviations

6. Concluding remarks

In this paper, I have studied the inflectional behavior of 3700 verbs in Spanish and have proposed a somehow innovative description of the regular inflection of such verbs by combining a stem-based approach with a more traditional approach based on generalized affixation. In the description I propose verbs in Spanish divide into two large inflectional classes whose membership is predictable from the shape of the lexical stem. Only one such class is productive. Then I have explored deviations from such basic inflection by way of stem alternation patterns, which are all morphomic in nature. To understand the distribution of the patterns, it is more convenient to see verbs in terms of stem classes. Once the descriptive apparatus was presented, I then introduced the question as to how we can deal with inflectional deviations. I proposed two simple approaches to the phenomenon based on a straight-forward comparison of two models of inflectional complexity. One is a Kolmogorov-style model, according to which a verb with a stem alternation pattern would be inflectionally more complex than a basic verb because it needs of a longer description. The other is a model of complexity based on implicative relations. Under such a model, stem alternation patterns may differ in complexity weight under specific circumstances depending on how predictable they are. The second model, which is aimed to reduce the complexity of a system when implicative relations are found, involves a series of notebooks of information on what to base the implicative relations. I have proposed that the descriptions involved in the making of such notebooks is a type of information that should also be stored somewhere in the system, but probably at a less costly price.

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APPENDIX

		SER 'be'		IR 'go'				SER 'be'		IR 'go'	
PST.IND	1SG	fuí	A	fuí	A	FUT.IND	1SG	se-ré	F	i-ré	F
	2SG	fuí-ste	A	fuí-ste	A		2SG	se-rás	F	i-rás	F
	3SG	fué	B	fué	B		3SG	se-rá	F	i-rá	F
	1PL	fuí-mos	A	fuí-mos	A		1PL	se-rémos	F	i-rémos	F
	2PL	fuí-steis	A	fuí-steis	A		2PL	se-réis	F	i-réis	F
	3PL	fué-ron	B	fué-ron	B		3PL	se-rán	F	i-rán	F
IMPF.SUB	1SG	fué-ra	B	fué-ra	B	COND.IND	1SG	se-ría	F	i-ría	F
	2SG	fué-ras	B	fué-ras	B		2SG	se-rías	F	i-rías	F
	3SG	fué-ra	B	fué-ra	B		3SG	se-ría	F	i-ría	F
	1PL	fué-ramos	B	fué-ramos	B		1PL	se-ríamos	F	i-ríamos	F
	2PL	fué-raís	B	fué-raís	B		2PL	se-ríais	F	i-ríais	F
	3PL	fué-ran	B	fué-ran	B		3PL	se-rían	F	i-rían	F
PRS.SUB	1SG	séa	C	váya	C	INF	sé-r		F	i-r	F
	2SG	séa-s	C	váya-s	C	IMP	2SG	sé	F	vé	H
	3SG	séa	C	váya	C		2PL	sé-d	F	i-d	F
	1PL	séa-mos	C	váya-mos	C	PST.PTCP	sido		F'	i(i)do	F'
	2PL	séa-is	C	váya-is	C						
	3PL	séa-n	C	váya-n	C						
IMPF.IND	1SG	éra	D	íba	D	PRS.IND	1SG	só-(o)y	G	v(a)-óy	G
	2SG	éra-s	D	íba-s	D		2SG	ére-s	H	vá-s	G
	3SG	éra	D	íba	D		3SG	és	I	vá	G
	1PL	éra-mos	D	íba-mos	D		1PL	só-mos	G	vá-mos	G
	2PL	éra-is	D	íba-is	D		2PL	só-is	G	vá-is	G
	3PL	éra-n	D	íba-n	D		3PL	só-n	G	vá-n	G
GER		sié-ndo	E	yé-ndo	E						

Table I. IR 'go' and SER 'be' (different letters indicate different stems)

		Stem level	TAM/ NF	PER/ NUM	Stress	Forms
INF		bende Xe ^{LEX}	-r		II	/bendér/ <i>vender</i>
IMP	2SG	bende	—		I	/bénde/ <i>vende</i>
	2PL	bende	-d		II	/bendéd/ <i>vended</i>
PRS.IND	1SG	bend(e)	-o		I	/béndo/ <i>vendo</i>
	2SG	bende	-s		I	/béndes/ <i>ventas</i>
	3SG	bende	—		I	/bénde/ <i>vende</i>
	1PL	bende	-mos		II	/bendémos/ <i>vendemos</i>
	2PL	bende	-is		II	/bendéis/ <i>vendéis</i>
	3PL	bende	-n		I	/bénden/ <i>venden</i>
FUT.IND	1SG	bende	-re	—	III	/benderé/ <i>venderé</i>
	2SG	bende	-ra	-s	III	/benderás/ <i>venderás</i>
	3SG	bende	-ra	—	III	/benderá/ <i>venderá</i>
	1PL	bende	-re	-mos	III	/benderémos/ <i>venderemos</i>
	2PL	bende	-re	-is	III	/benderéis/ <i>venderéis</i>
	3PL	bende	-ra	-n	III	/benderán/ <i>venderán</i>
COND.IND	1SG	bende	-ria	—	III	/bendería/ <i>vendería</i>
	2SG	bende	-ria	-s	III	/benderías/ <i>venderías</i>
	3SG	bende	-ria	—	III	/bendería/ <i>vendería</i>
	1PL	bende	-ria	-mos	III	/benderíamos/ <i>venderíamos</i>
	2PL	bende	-ria	-is	III	/benderíais/ <i>venderíais</i>
	3PL	bende	-ria	-n	III	/benderían/ <i>venderían</i>
PST.IND	1SG	bendi Xi ^{LEX} →Xi	—		III	/bendí/ <i>vendí</i>
	2SG	bendi	-ste		II	/bendíste/ <i>vendíste</i>
	3SG	bendi	-o		III	/bendió/ <i>vendió</i>
	1PL	bendi	-mos		II	/bendímos/ <i>vendimos</i>
	2PL	bendi	-steis		II	/bendísteis/ <i>vendísteis</i>
	3PL	bendie Xe ^{LEX} →Xje	-ron		II	/bendiéron/ <i>vendieron</i>
IMPF.SUB	1SG	bendie	-ra	—	II	/bendiéra/ <i>vendiera</i>
	2SG	bendie	-ra	-s	II	/bendiéras/ <i>vendieras</i>
	3SG	bendie	-ra	—	II	/bendiéra/ <i>vendiera</i>
	1PL	bendie	-ra	-mos	II	/bendiéramos/ <i>vendieramos</i>
	2PL	bendie	-ra	-is	II	/bendiérais/ <i>vendierais</i>
	3PL	bendie	-ra	-n	II	/bendiéran/ <i>vendieran</i>
GER		bendie	-ndo		II	/bendiéndo/ <i>vendiendo</i>
PRS.SUB	1SG	benda Xe ^{LEX} →Xa	—		I	/bénda/ <i>venda</i>
	2SG	benda	-s		I	/béndas/ <i>ventas</i>
	3SG	benda	—		I	/bénda/ <i>venda</i>
	1PL	benda	-mos		II	/bendámos/ <i>vendamos</i>
	2PL	benda	-is		II	/bendáis/ <i>vendáis</i>
	3PL	benda	-n		I	/béndan/ <i>vendan</i>
IMPF.IND	1SG	bendia Xe ^{LEX} →Xja	—		II	/bendía/ <i>vendía</i>
	2SG	bendia	-s		II	/bendías/ <i>vendías</i>
	3SG	bendia	—		II	/bendía/ <i>vendía</i>
	1PL	bendia	-mos		II	/bendíamos/ <i>vendíamos</i>
	2PL	bendia	-is		II	/bendíais/ <i>vendíais</i>
	3PL	bendia	-n		II	/bendíaan/ <i>vendían</i>
PST.PTCP		bendido Xe ^{LEX} →Xido	—		II	/bendído/ <i>vendido</i>

Table II. The paradigm of a regular verb of Class II of stem class /e#/

	Stem level		TAM/ PER/ NF NUM	Stress	Forms	
INF		bibi Xi ^{LEX}	-r	II	/bibír/	<i>vivir</i>
IMP	2SG	bibi	—	I, Xi(C)# → Xe(C)#	/bíbe/	<i>vive</i>
	2PL	bibi	-d	II	/bibíd/	<i>vivid</i>
PRS.IND	1SG	bib(i)	-o	I	/bíbo/	<i>vivo</i>
	2SG	bibi	-s	I, Xi(C)# → Xe(C)#	/bíbes/	<i>vives</i>
	3SG	bibi	—	I, Xi(C)# → Xe(C)#	/bíbe/	<i>vive</i>
	1PL	bibi	-mos	II	/bibímos/	<i>vivimos</i>
	2PL	bibi	-(i)s	II	/bibis/	<i>vivís</i>
	3PL	bibi	-n	I, Xi(C)# → Xe(C)#	/bíben/	<i>viven</i>
FUT.IND	1SG	bibi	-re —	III	/bibiré/	<i>viviré</i>
	2SG	bibi	-ra -s	III	/bibirás/	<i>vivirás</i>
	3SG	bibi	-ra —	III	/bibirá/	<i>vivirá</i>
	1PL	bibi	-re -mos	III	/bibirémos/	<i>viviremos</i>
	2PL	bibi	-re -is	III	/bibiréis/	<i>viviréis</i>
	3PL	bibi	-ra -n	III	/bibirán/	<i>vivirán</i>
COND.IND	1SG	bibi	-ria —	III	/bibiría/	<i>viviría</i>
	2SG	bibi	-ria -s	III	/bibirías/	<i>vivirías</i>
	3SG	bibi	-ria —	III	/bibiría/	<i>viviría</i>
	1PL	bibi	-ria -mos	III	/bibiríamos/	<i>viviríamos</i>
	2PL	bibi	-ria -is	III	/bibiríais/	<i>viviríais</i>
	3PL	bibi	-ria -n	III	/bibirían/	<i>vivirían</i>
PST.IND	1SG	bibi Xi ^{LEX} → Xi	—	III	/bibí/	<i>viví</i>
	2SG	bibi	-ste	II	/bibíste/	<i>vivíste</i>
	3SG	bibi	-o	III	/bibió/	<i>vivió</i>
	1PL	bibi	-mos	II	/bibímos/	<i>vivimos</i>
	2PL	bibi	-steis	II	/bibísteis/	<i>vivísteis</i>
	3PL	bibie Xi ^{LEX} → Xje	-ron	II	/bibiéron/	<i>vivieron</i>
IMPF.SUB	1SG	bibie	-ra —	II	/bibiéra/	<i>viviera</i>
	2SG	bibie	-ra -s	II	/bibiéras/	<i>vivieras</i>
	3SG	bibie	-ra —	II	/bibiéra/	<i>viviera</i>
	1PL	bibie	-ra -mos	II	/bibiéramos/	<i>vivieramos</i>
	2PL	bibie	-ra -is	II	/bibiérais/	<i>vivierais</i>
	3PL	bibie	-ra -n	II	/bibiéran/	<i>vivieran</i>
GER		bibie	-ndo	II	/bibiéndo/	<i>viviendo</i>
PRS.SUB	1SG	biba Xi ^{LEX} → Xa	—	I	/bíba/	<i>viva</i>
	2SG	biba	-s	I	/bíbas/	<i>vivas</i>
	3SG	biba	—	I	/bíba/	<i>viva</i>
	1PL	biba	-mos	II	/bibámos/	<i>vivamos</i>
	2PL	biba	-is	II	/bibáis/	<i>viváis</i>
	3PL	biba	-n	I	/bíban/	<i>vivan</i>
IMPF.IND	1SG	bibia Xi ^{LEX} → Xja	—	II	/bibía/	<i>vivía</i>
	2SG	bibia	-s	II	/bibías/	<i>vivías</i>
	3SG	bibia	—	II	/bibía/	<i>vivía</i>
	1PL	bibia	-mos	II	/bibíamos/	<i>vivíamos</i>
	2PL	bibia	-is	II	/bibíais/	<i>vivíais</i>
	3PL	bibia	-n	II	/bibíaan/	<i>vivían</i>
PST.PTCP		bibido Xi ^{LEX} → Xido	—	II	/bibído/	<i>vivido</i>

Table III. The paradigm of a regular verb of Class II of stem class /i#/