Lexicon Optimization Reconsidered

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This paper takes up the hitherto neglected issue of the lexicon, and shows how the lexicon can be projected from the structure of a language's grammar, seeking to resolve the tension between a desire to minimize lexical specification and a desire to maximize input-output faithfulness in terms of the organization of the lexicon. First, I will show that the earlier version of Lexicon Optimization, proposed by Prince and Smolensky (1993), results in a less economical lexicon and argue that predictable feature values must be unspecified in the lexical representation irrespective of whether they show alternating patterns or not. And then, through a close examination of various allophonic and allomorphic cases, I will propose that Lexicon Optimization must be properly reformulated from a form-by-form optimization to a global optimization reflecting the segmental inventory and morphemic paradigm. The main point of this paper is that the presence of a lexical economy constraint *SPEC has some consequences for the more restrictive lexicon.

Key words: lexicon optimization, richness of the base, paradigm, allomorphy, specification

1. Introduction

The development of phonological theory from rule-based generative theory to constraint-based Optimality Theory (hereafter OT) calls for a new perspective on the notion of underlying representation. The reason is that surface-oriented OT centers only on the surface-true generalizations and pays little attention to the nature of underlying representation. Under the principle of Richness of the Base and Lexicon Optimization, OT approach naturally results in the postulation of a larger and more concrete set of underlying representations. I will first argue against the earlier version of Lexicon Optimization on the ground of redundancy. In several cases discussed here I will show that it is necessary to posit a smaller

inventory of more abstract underlying forms that excludes fully predictable feature values. This point is illustrated in allophonic and allomorphic phenomena in English.

This paper is structured as follows. In the next section, I will consider the two main different approaches to underlying representation: SPE-type system and OT. Specific attention will be paid to the independent motivation of the presence of the lexicon as a repository of idiosyncratic properties. Section 3 contains an extended discussion of Lexicon Optimization in OT, indicating why Prince and Smolensky (1993)'s Lexicon Optimization would be a problem for the lexical economy. In section 4, I will examine more closely allophonic and allomorphic segmental phenomena in English, giving an analysis of them using lexical economy constraint *SPEC. In section 4.1, I will discuss allophonic alternations evidenced in nasalized vowels and aspirated stops of English, and give a more plausible alternative analysis which faithfully reflects English phoneme inventory. Section 4.2 describes a case of allomorphic alternation, and argues that phonologically predictable alternations can be handled under the lexical economy principle, whereas phonologically arbitrary morphological alternations must be lexically marked in the underlying representation. It will be strongly suggested that a more illuminating explanation of the lexical structure in allomorphic phenomena should rely not on their alternability but on their predictability. Section 5 summarizes the key points of this paper with some implications.

2. Lexicon as a Mental Reality

Traditionally, the lexicon as a mental reality not only collects the idiosyncratic and unpredictable properties but also inherent properties in that the structure of a language's grammar is strongly reflected in its lexicon, while the predictable properties are to be characterized separately by the operating grammar. Lexicon stores all and only contrastive properties of morphemes of a language, including phonological, morphological, syntactic, and semantic properties. As the question of the overall character and organization of the lexicon is a massive one, this paper will limit itself to the problem of its economy and redundancy with respect to the phonological system.

Within the standard framework of SPE, all regularities are abstracted

out and presented in the form of rules. This results in a lexicon that is the repository of pure unpredictability, which is reduced to an absolute minimum of specification. The key principles of evaluation in classical generative phonology are related to the extreme economy of the lexicon, which implies that the best linguistic system is the one that has maximized generality and minimized specification. Considerations of such lexical economy, however, does face the cost of extremely abstract underlying forms and various crazy rules which transform these underlying forms into surface forms.

This raises the issue of abstractness, which leads to the problem of recoverability as well. Though there have of course been proposals that aim to reduce or eliminate the abstractness of the underlying forms, including Kiparsky (1973)'s Alternation Condition and much more radical condition of Hooper (1976)'s True Generalization Condition, these are of no real help to accounting for all the phenomena of alternation in a principled fashion. The problem of abstractness still remains with us.

Optimality Theory, on the other hand, takes quite the opposite path. It proposes that the lexicon provides the input specifications which are to be submitted to the Generator, where output candidates are generated and then evaluated to select the optimal candidate. It presents a picture of a lexicon that stores whole words, which shows a sharp contrast with the standard generative grammar. In output-based OT, surface-true alternations can be understood as the direct result of the pressure to observe the surface constraints. This approach naturally results in the postulation of a more concrete underlying representations, that is, any given morpheme's phonological exponents must be identical in underlying and surface form. It follows that there is no reason to think that a heavy premium needs to be placed on the economy of lexical storage and that, in effect, a considerable amount of redundancy in storage should be tolerated. In fact, some authors have argued that OT removes the need for any lexicon, for all types of variation can result simply from a ranking schema (Hammond, 1995; Russell, 1995; Yip, 1996; among others). Their arguments are based on the idea that the phonological properties of morphemes are not encoded in underlying representations, but in ranked constraints.

This paper argues against such a radical surface-oriented view, and in favor of the independent role of the lexicon as having inherent, not grammar-driven, properties: conceptually, the lexicon of a language is a

discrete level that contains all and only the idiosyncratic information about a language. Considering that the lexicon, as a sample from the inventory of possible inputs, must be devoid of redundancy, that is, it contains no predictable information at all, lexical items should be represented neither in a phonetic form nor in an arbitrary form with no phonetic plausibility, that is, between these two extremes. It follows that there exists some divergence between underlying representations and inputs.

For the purposes of encoding the phonological information inherent in morphemes, I prefer the framework that underlying representations are argued to be under the principle of lexical economy. It is in conformity with the linguistic mind. In the following sections, I will demonstrate that some mechanism is needed for the proper underlying representation, which takes the morphemic paradigm and segmental inventory into consideration.

3. Lexicon Optimization in OT

In OT, all the grammatical generalizations are expressed by the interactions of constraints at the level of the output, rather than at the input level. On the issue of what inputs are made available, the output orientation of OT brings with it Richness of the Base, which roughly asserts that ideally all inputs are possible. Thus, according to the principle of Richness of the Base, there are no language-particular constraints on underlying representation, and hence no concept of underlying representation, because the differences in language structures result from different constraint rankings, never from different inputs. All the possible inputs are to converge on the occurring surface inventory of a language through the constraint ranking.

However, there arises a question of which of the universally available inputs is paired with a particular morpheme, which is particularly relevant to the acquisition of phonology. With respect to the problem of learning the language-dependent underlying forms of morphemes, there is a distinction to be made between possible input forms and plausible underlying representations for actual lexical items. The former is drawn from the infinitely unrestricted pool of possible linguistic structures, while the latter from the finite morphemes of a particular language.

In general, in cases where many different inputs may converge on a particular output form, only the input which diverges minimally from the output will be selected by the language learner as the lexical representation. In other words, language learners have at their disposal the strategy of Lexicon Optimization in choosing the right input. Prince and Smolensky (1993) propose the principle of Lexicon Optimization as a means of determining the correct underlying representation.

(1) Lexicon Optimization
Suppose that several different inputs I_1, I_2, ..., I_n, when parsed by a grammar G lead to corresponding outputs O_1, O_2, ..., O_n, all of which are realized as the same phonetic form Φ - these inputs are all phonetically equivalent with respect to G. Now one of these outputs must be the most harmonic, by virtue of incurring the least significant violation marks: suppose this optimal one as labelled O_k. Then the learner should choose, as the underlying form for Φ, the input I_k (Prince & Smolensky, 1993, p. 192).

As stated in (1), the Lexicon Optimization principle favors the analyses which minimize input-output disparities, and which maximize faithful mapping by avoiding *Faith marks. With Lexicon Optimization, the learner, given a set of inputs which yield the same result and a set of ranked constraints of the language, will select as the optimal underlying representation the input form which most closely resembles the output form, thus leading to the fewest faithfulness violations. In short, the most well-formed output parse is chosen as the proper underlying representation among the universal set of input candidates.

For the illustration of its attractive consequences, consider the syllabifications of the input forms /CVCV/, /CVC/ and /VCV/ in a given language L. For the sake of argument, it will be assumed that the constraints of ONSET, NOCODA, MAX and DEP are responsible for the well-formed surface realizations, and further assumed that ONSET, NOCODA, and MAX are ranked higher than DEP. Considering only four likely output candidates for each input, we can construct tableaux as in (2) below, which show the computation of the optimal candidate.

(2) ONSET, NOCODA, MAX ≫ DEP

/CVCV/	ONSET	NOCODA	MAX	DEP
☞CV.CV				
CVC.V	*!	*!		
CV.CVC		*!		*!
CVC		*!	*!	

/CVC/	ONSET	NOCODA	MAX	DEP
☞CV.CV				*
CVC.V	*!	*!		*
CVC		*!		
CV			*!	

/VCV/	ONSET	NOCODA	MAX	DEP
☞CV.CV				*
CVC.V	*!	*!		*
V.CV	*!			
CV			*!	

Note that all the three optimal outputs converge on the same phonetic form. With the help of the 'tableau des tableaux' technique proposed by Itô, Mester, and Padgett (1995), we can compare each of the optimal outputs for its harmonic status with the corresponding input. With Lexicon Optimization, the input form which most closely resembles the output form with the fewest faithfulness violations is chosen as the real underlying representation, as exemplified in (3).

(3) Lexicon Optimization

Input	Output	FAITH
☞/CVCV/	CV.CV	
/CVC/	CV.CV	*! (DEP-V)
/VCV/	CV.CV	*! (DEP-C)

The tableau in (3) illustrates the way the real input is chosen out of the potential inputs. As can be seen in the above hypothetical case, Lexicon Optimization is significant when multiple inputs converge into a single output. So far the picture looks good.

In spite of some of its attractive consequences, however, this version of Lexicon Optimization which heavily favors fully specified inputs encounters problems when grappling with allophonic and allomorphic variations. In the next section henceforth, I will present the problematic cases and show how we can reformulate Lexicon Optimization within the framework of OT.

4. Lexicon Optimization Reconsidered

4.1. Lexicon Optimization in Allophonic Alternation

With respect to the underlying representation, each lexical entry must contain specified phonological features which determine the phonetic form of the item in all contexts. If we choose to represent each lexical item by the set of its phonetic representations, we would be treating all phonetic variations as exceptions and would be unable to express the phonetic regularities and general phonological processes in any way. Therefore, underlying lexical representations should be chosen in such a way as to maximize the simplicity of the grammar, and any redundant specification should be excluded from the lexicon which is predictable from the grammar to the maximal extent possible.

Consider the case of allophonic alternation where the variants are fully predictable from the phonological contexts. In English, oral and nasalized vowels are allophones; vowels are nasalized when they directly precede a tautosyllabic nasal stop, and are oral in all other contexts. How can this allophonic pattern be stated in the original formulation of Lexicon Optimization? Richness of the Base implies that both specifications of oral and nasalized vowels can be allowed in the input string. No matter what vowel is present in the input form, the same optimal candidate is selected by the top ranked markedness constraint, which is a case of neutralization. In sum, the underlying orality or nasality of the vowel is completely irrelevant in allophonically alternating patterns. This is illustrated in the tableaux (5).

(4) $*V_{NASAL}$: Vowels must not be nasalized.
$*V_{ORAL}N$: Before a tautosyllabic nasal, vowels must not be oral.
IDENT-IO[nasal]: Correspondent segments in input and output have identical values for feature [nasal].

(5) $*V_{NASAL} \gg *V_{ORAL}N \gg$ IDENT-IO[nasal]

/mæ̃n/	$*V_{ORAL}N$	$*V_{NASAL}$	IDENT-IO[nasal]
☞[mæ̃n]		*	
[mæn]	*!		*

/mæn/	*VORALN	*VNASAL	IDENT-IO[nasal]
☞[mæ̃n]		*	*
[mæn]	*!		

(6) Lexicon Optimization in Allophonic Alternation of Nasality in Vowels

Input	Output	FAITH
☞ /mæ̃n/	[mæ̃n]	
/mæn/	[mæ̃n]	*! (IDENT-IO[nasal])

Given two competing input forms as in (6), one fully specified and the other partially specified, the fully specified alternative will be preferred, all else being equal. Here in this case the optimal underlying representation for [mæ̃n] is /mæ̃n/, due to the original straightforward Lexicon Optimization. This leads to a more drastic conclusion: there is no underspecification in the underlying representation at all. But this is at odds with the principle that the lexicon should not contain any specification which can be predicted from the grammar. Nasality is never distinctive in vowels in English, and vowel nasalization before tautosyllabic nasals is totally redundant, thus the import of underlying nasality of the vowel results in the phonological inertness. A revision to the original Lexicon Optimization is to assume the possibililty that partially unspecified lexical representations can on occasion be posited, that is, underlying representations cannot contain any redundant specification, such as the feature of [nasal] here in this case. So it is clear that the underlying representation /mæn/ is preferred to /mæ̃n/.

Let us take another example of allophonic alternation. It is well-known in English that stops are aspirated before a stressed vowel. Under the

principle of Richness of the Base, both values of [spread glottis] are available in the input string. With the high ranking of markedness constraint, the same optimal candidate is chosen regardless of the underlying specification of aspiration, which is exemplified in (8).

(7) ASPIRATION: Word-initial voiceless stops (and affricates) must be aspirated in English.
*ASPIRATION: Stops must not be aspirated.
IDENT-IO[spread glottis]: Correspondent segments in input and output have identical values for feature [spread glottis].

(8) ASPIRATION/#___ ≫ *ASPIRATION ≫ IDENT-IO[spread glottis]

/pʰay/	ASPIRATION/#___	*ASPIRATION	IDENT-IO[spread glottis]
☞[pʰay]		*	
[pay]	*!		*

/pay/	ASPIRATION/#___	*ASPIRATION	IDENT-IO[spread glottis]
☞[pʰay]		*	*
[pay]	*!		

(9) Lexicon Optimization in Allophonic Alternation of Aspiration in Stops

Input	Output	IO-FAITH
☞ /pʰay/	[pʰay]	
/pay/	[pʰay]	*! (IDENT-IO[spread glottis])

Within the earlier Lexicon Optimization, the input that is maximally harmonious to the output is chosen as the lexical representation of *pie*, here in this case /pʰay/. But this violates the canonical restrictions on segments which can appear in the lexicon because aspirated stops are not part of the phoneme inventory of English. This means that the feature of aspiration is not needed for classifying the phonemes of English, but only needed for describing the phonetic quality of English sounds. The specification of [spread glottis] in the lexical representation is redundant in the sense that this reflects the grammar of English. Under the assumption that the lexicon must be devoid of redundancy, the aspiration of voiceless stops should not be stored in the lexicon and thus English stops should be unspecified for [spread glottis] underlyingly.

The well-formed phonological structures are specified by two components: the grammar and the lexicon. The grammar is a set of general constraints, while the lexicon lists everything which is itself idiosyncratic. In this sense the lexicon contains only feature values that are not predictable nor incorporated in the grammar. In order to restrict the lexicon in the proper way, I propose the simplicity criterion that featural specification should be excluded from the lexicon to the maximal extent possible whose distributional patterns can be encoded by the grammar. As a formulation of the economy criterion as to the organization of the lexicon, I propose a constraint of minimal specification with minimal redundancy on the underlying representation:

(10) No Specification (*SPEC): Redundant features must be absent in the underlying representation.[1)]

The constraint of No Specification (*SPEC) penalizes any redundant specification, which is a kind of specialization of the general constraint *STRUC. Each redundant feature in an input causes a violation of this constraint; thus, among phonetically equivalent inputs, *SPEC favors the one with fewest redundant feature specifications. With *SPEC outranking FAITH, Lexicon Optimization selects /mæn/ and /pay/ over /mn/ and /p^{h}ay/ respectively in the above English examples.

(11) Revised Lexicon Optimization in Allophonic Alternation of Nasality in Vowels

Input	Output	*SPEC	IO-FAITH
/mæ̃n/	[mæ̃n]	*! ([nasal])	
☞ /mæn/	[mæ̃n]		* (IDENT-IO[nasal])

1) A stronger version of *SPEC constraint has been originally proposed by Prince and Smolensky (1993).

*SPEC: Underlying material must be absent (Prince & Smolensky, 1993, p. 196).

They add that in the unmarked case FAITHFULNESS dominates *SPEC and that *SPEC makes no change whatever to any of the analyses they have considered. In this paper, however, I will show that *SPEC plays a crucial role in terms of lexical economy.

(12) Revised Lexicon Optimization in Allophonic Alternation of Aspiration in English Stops

Input	Output	*SPEC	IO-FAITH
/p^{h}ay/	[p^{h}ay]	*! ([asp])	
☞ /pay/	[p^{h}ay]		* (IDENT-IO[asp])

Since minimizing FAITH violations and thereby minimizing the disparities between input and output is less important than minimizing the lexical redundancy, /mæn/ and /pay/ is selected as the optimal underlying form. By relying upon a lexicon evaluation metric *SPEC, we can capture an important aspect of the parsimonious lexicon, that is, minimal specification with minimal redundancy. In the following, I will consider how *SPEC can solve the problem of limiting allomorphy.

4.2. Lexicon Optimization in Allomorphic Alternation

The earlier formulation of Lexicon Optimization, proposed by Prince/ Smolensky (1993), also comes under severe pressure in the cases of alternating patterns. Specifically Lexicon Optimization is not successful in covering the various cases of allomorphy.

Allomorphy is one of the interesting topics in phonology and morphology, and has engendered much discussion. Phonologically governed allomorphy is perfectly regulated in quite predictable ways by the phonological properties, whereas morphologically governed allomorphy shows varying degrees of unpredictability and thus would seem to involve brute-force memory.[2] In this paper I will make a discussion on both of them from the OT perspective.

4.2.1. Lexicon Optimization in Phonologically Governed Allomorphic Alternation

In this section, I will show through the close examination of the allomorphic cases that the redundant predictability of a given feature value does justify its exclusion from the lexical representation. Let us

2) In the literature the differentiation between phonological and morphological alternations has been based on various criteria: automaticity or obligatoriness or generality, phonetic plausibility or motivation, productivity, and naturalness. But these are not dichotomous, and there exist cases of a continuum between phonological and morphological alternations. Here I will concentrate on the characteristics of processes relating inputs to outputs, that is, whether the alternations are effected by phonological or morphological/lexical conditioning.

examine the case of phonologically conditioned alternation. As a concrete example, consider the realization of the negative morpheme *in-* in English (Ahn, 2000).

(13)	[im-]	[in-]	[iŋ-]	[il-]	[ir-]
	impossible	intolerable	incubate	illegal	irrational
	impatient	indecent	incubus	illicit	irregular
	immovable	insincere	inculcate	illegible	irrelevant
	immoral	inaudible	inculpate	illogical	irresistible
	imbalance	inelegance	increment	illegitimate	irreducible

Normally the negative morpheme *in-* has several different variants in actual phonetic representations due to the quality of following the sound: [im-] before a labial consonant, [iŋ-] before a velar consonant,[3] [il-] before *l*, [ir-] before *r*, and [in-] elsewhere, i.e. before an alveolar consonant or before a vowel. It is quite obvious that this variation is not fortuitous. In short, the negative morpheme *in-* shows a predictable pattern of surface distribution, and English grammar is not complicated by the totally predictable variation like this at all. To recapitulate, the allomorphic distribution of English negative morpheme is not an idiosyncratic property of this particular affix, but is rather a generally conditioned result of assimilation, applying to many other sound patterns as well. Regular variations such as this are not matters for the lexicon, which should contain only idiosyncratic properties of items; since the variation like that displayed by the negative prefix *in-* is fully determined by general English phonology.

The disadvantage resulting from the mere listing of all the regular allomorphs in the lexicon is that the phonological computation of the negative allomorphs is not expressed anymore, and thus missing certain generalizations concerning allomorphy. In order to capture the linguistic mind that this allomorphic alternation is not independent of each other

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3) The realization of [iŋ-] does depend on the location of primary stress in the output, that is, [iŋ-] may surface only if the prefix has a primary stress.

(i) [iŋ-] with primary stress on the prefix:
incubate, incubus, inculcate, inculpate, increment, etc.
(ii) [in-] with no stress on the prefix:
include, incapable, inconvenient, incredible, etc.

I am deeply grateful to an anonymous reviewer for informing me of this point.

but phonologically motivated within an inter-related paradigm, linguists have assumed that these allomorphs share a single underlying representation. By positing a single underlying representation for these, we capture the fact that the regular alternation in the realization of allomorphy is due to assimilation having a phonetic basis.

According to the principle of Richness of the Base and Lexicon Optimization of OT, however, there are as many underlying representations as the surface output forms, which is exemplified in (14).

(14) Lexicon Optimization in Phonologically Governed Allomorphic Alternation

Input	Output	IO-FAITH
☞ /im/-possible	[impɔsəb]	
/iŋ/-possible	[impɔsəb]	*! (IDENT-IO[place])
/in/-possible	[impɔsəb]	*! (IDENT-IO[place])
☞ /in/-tolerable	[intɔlərəb]	
/im/-tolerable	[intɔlərəb]	*! (IDENT-IO[place])
/iŋ/-tolerable	[intɔlərəb]	*! (IDENT-IO[place])
☞ /iŋ/-cubate	[iŋkjubeit]	
/im/-cubate	[iŋkjubeit]	*! (IDENT-IO[place])
/in/-cubate	[iŋkjubeit]	*! (IDENT-IO[place])

As can be evidenced in (14), Lexicon Optimization favors underlying representations that are as close to the surface representations as possible, with each surface alternant of a morpheme having its own input with fuller specifications. The deficiency in Lexicon Optimization is that it attempts a form-by-form optimization without taking into consideration the optimization of the paradigm associated with the relevant prefix *in-*, thus missing the generalization that a nasal consonant assimilates to the place of articulation of the consonant that follows it. Here it is the very redundancy of such place assimilation that entails its phonological inertness.

To properly reformulate Lexicon Optimization from a form-by-form optimization to a general optimization, I will argue against blindly applying Lexicon Optimization to individual forms in favor of paradigm-evel Lexicon Optimization. Tesar and Smolensky (1996) proposes paradigm-evel Lexicon Optimization, where optimization applies not to individual

forms but to the entire paradigms. This version of Lexicon Optimization assumes that identity of the expression of a morpheme is required across its paradigm, which is characterized by an output-output faithfulness constraint. Consider the syllable-final devoicing in German (Tesar & molensky, 1996, p. 40):

(15) a. [tak] 'day' NOM SING
b. [tag+ə] 'days' NOM PL

(16) Lexicon Optimization Tableau for [tak] ~ [tagə]

	overt part	ONSFAITH	*VOI	FAITH	OO-FAITH
a. ☞/tag/ + { ∅ }	[tak]			*	
{ ə }	[tagə]		*		*
b. /tak/ + { ∅ }	[tak]				
{ ə }	[tagə]	*!	*	*	*

Among all those that give the correct surface forms, the one which yields the maximally harmonious paradigm is selected to be the underlying form of a morpheme, here in the German case (16a) /tag/. In (16), the positionally sensitive faithfulness constraint ONSFAITH that demands the faithfulness to underlying voicing in the onset position is the key to the choice of underlying form /tag/.

Going back to the nasal assimilation of English negative prefix *in-*, I will demonstrate the necessity of paradigm-level Lexicon Optimization in terms of affix level as well, and argue against grammar-blind Lexicon Optimization. The claim here is that a unique lexical representation must be posited for the phonologically motivated alternants of a morpheme and that the burden of explanation for the alternation remains on the grammar at hand, which comes for free. So I will assume, following Kiparsky (1973)'s alternation condition[4], that /in-/ rather than /im-/ or /iŋ-/ is the default form on the ground that the occurrence of [in-] before vowels is not due to place assimilation, since vowels do not have definite place cues. Only when we posit /in-/ as the underlying representation

4) Kiparsky (1973) proposed, as an efficient way of curbing the abstractness of analyses, the alternation condition stating that underlying segments cannot be postulated separately unless they correspond to surface phonetic segments.

from which the other allomorphs are derived, we can explain the phonetic plausibility without resort to any extra strategy.

In capturing the paradigmatic effect of the relevant morphemes in an intuitive fashion, *SPEC plays an indispensible role as it does in allophonic alternation. Tableau (17) illustrates the specification minimization constraint *SPEC at work in the overall paradigm of affix alternations. In this tableau, input candidate with a single lexical representation wins because the optimal input for the alternating prefixes is default-marked for the feature [place].

(17) Revised Lexicon Optimization in Phonologically Governed Allomorphic Alternation

Input	Output	*SPEC	IO-FAITH
☞ /in/ + possible	[im-possible]		* (IDENT-IO[place])
tolerable	[in-tolerable]		
cubate	[iŋ-cubate]		* (IDENT-IO[place])
legal	[il-legal]		* (IDENT-IO[place])
rational	[ir-rational]		* (IDENT-IO[place])
/im/ + possible	[im-possible]		
/in/ + tolerable	[in-tolerable]		
/iŋ/ + cubate	[iŋ-cubate]	*!*** ([place])	
/il/ + legal	[il-legal]		
/ir/ + rational	[ir-rational]		

Single unique lexical representation is opted only for predictable alternating structure, where any discrepancies between lexical and surface representation are regulated by the grammar. In other words, the choice among alternative exponents of the category follows from the general principles of phonology, here in the above example, by place assimilation. This is also congruous with the standard view of paradigm uniformity that words in a morphologically related paradigm do share a unique morpheme. To summarize, I have argued that some revision of original Lexicon Optimization is necessary, that grammar-blind straightforward application of Lexicon Optimization cannot be maintained, and that the predictable structures must be excluded in the lexical representation.

Things change, however, where allomorphic variation does not result from general phonology. In what follows, I will consider the case of morphologically governed alternation and suggest that all the allomorphs

showing irregular patterns be underlyingly present.

4.2.2. Lexicon Optimization in Morphologically Governed Allomorphic Alternation

There can be some allomorphy of stems found, which is conditioned by affixes. When a certain suffix is attached to a base in English, a special allomorph of the stem may be selected, some of which can be seen in (18).

(18) Stem Allomorphs in Suffixed Words

a. stem allomorphs in derivation		b. stem allomorphs in inflection	
extend	extensible	leaf	leaves
defend	defensible	thief	thieves
perceive	perceptible	calf	calves
corrode	corrosive	knife	knives
evade	evasive	wife	wives
invert	inversion	wolf	wolves

These are the cases where phonological factors play no role in the selection of appropriate stem allomorphs. Instead, the choice of a special allomorph may be dependent on the morphological or grammatical reason, i.e. it requires a special morphological or grammatical context without any phonetic motivation for the selection. For example, in (18a), certain verbs take one allomorph when they occur in isolation and a different allomorph before *-ible*, *-ive*, and *-ion*. In (18b), the presence of the plural morpheme determines the /leav-/ and /thiev-/ allomorphs in nouns that belong to this group, which shows a big contrast with those which do not undergo final voicing (*chief-s*, *reef-s*, etc.). Given the grammar of English, there can be found no plausible reason why the plural of *leaf* is not **leafs* but *leaves*, although *chief* that rhymes with *leaf* takes the plural form *chiefs*. To recapitulate, it is impossible to derive one allomorph from the other by means of a fully predictable well-formedness constraint.

To effectively deal with the allomorphs which are distributed in such a fashion that it is not perspicuous phonologically, I discard the notion of a unique underlying representation, but instead argue that the lexicon supplies a set of allomorphs for the insertion in various morphological contexts. For *extend~extensible*, for example, two stem allomorphs have

to be listed, one that is subcategorized for adjectival suffixation, and the other that has no such subcategorization, the default allomorph. The default allomorph is chosen when the word is used as a simplex word. Here the constraint *SPEC becomes irrelevant, and the abstract input enjoys no special advantage.

(19) Lexicon Optimization in Morphologically Governed Allomorphic Alternation

Input	Output	*SPEC	IO-FAITH
☞ /extend/ + Φ /extens-/ + ible	[extend] [extensible]		
/extend/ + Φ /extend/ + ible	[extend] [extensible]		*!

Input	Output	*SPEC	IO-FAITH
☞ /leaf/ + Φ /leav-/ + s	[leaf] [leaves]		
/leaf/ + Φ /leaf/ + s	[leaf] [leaves]		*!

As can be seen in (19), Lexicon Optimization is strictly applied in order to determine the real input forms, and IO-faithfulness constraint chooses /extend/ and /extens-/ as the real stem input forms for *extend~extensible*, /leaf/ and /leav-/ for *leaf~leaves*, respectively. Note that the form with irregular allomorphs like (18) has more complex underlying representation than the one with regular allomorphs like (13). This is in good harmony with the linguistic mind that lexical representations are to be tempered by recoverability. To summarize, the conclusion to be drawn from these examples is whatever is unpredictable should be fully prespecified in underlying representation.

5. Conclusion

In this paper, I have argued that the earlier version of Lexicon Optimization proposed by Prince and Smolensky (1993) does not properly cover all the cases of allophonic and allomorphic cases, because the inputs selected by Lexicon Optimization are exactly identical to their

surface forms, which is counter-intuitive with respect to the mental lexicon. When considering that lexical representations should be chosen in such a way as to maximize the value of the grammar, underlying representations can be abstract in so far as they do serve to supply only phonotactically unpredictable shape of alternants.

I have distinguished the alternations into three categories: allophonic, phonologically predictable allomorphic, and phonologically arbitrary morphological alternations. In allophonic alternations, I proposed that Lexicon Optimization be performed on the phoneme inventory and that any allophonic features be removed from the lexical representations. In phonologically conditioned allomorphic alternations, I posited a unique lexical representation grounded on the paradigm, rather than on individual forms. In phonologically arbitrary morphological alternations, however, I adopted a fully specified underlying representation for each allomorph. In short, our renewed Lexicon Optimization causes a single unique lexical representation when the alternation is phonologically predictable, while it leads to a full specification when the condition is not met.

The predictions made by lexicon economy constraint *SPEC are diametrically opposed to those made by Lexicon Optimization, in that Lexicon Optimization favors underlying representations that are as close to the surface representation as possible, whereas *SPEC favors underlying representations that are as small as possible. Here in this paper I have considered several English cases in which a more explanatory analysis of allophony and allomorphy phenomena requires postulating a restricted economical lexicon and shown that constraints cannot replace underlying representation entirely, as has been suggested by Russell (1995), among others.

The idea that only predictable structures are maximally unspecified, with unpredictable information prespecified, is in harmony with our linguistic mind, and on the basis of it I prefer lexicon simplicity over the straightforward Lexicon Optimization. The resulting tension between recoverability and representational simplicity is resolved in such a way that phonological representations are as impoverished as possible, yet are still rich enough to relate unambiguously to their phonetic contents. To recapitulate, in this paper I have taken up the hitherto neglected issue of the lexicon, and claimed that redundancy or predictability plays a crucial role in establishing the lexical representation correctly. I hope that much work to find further arguments for proper underlying representations will be followed.

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