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Some principles of second language phonology

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The research we report here is intended to build an understanding of several well-known yet poorly comprehended problems relating to phonemic contrasts in the learning of L2 pronunciation. The competing influences of similarity and difference between native and target language sound systems, in particular, are central to this understanding, which we believe show that L2 phonology is a highly abstract enterprise parallel to the phonologies of primary languages, rather than – as has been assumed – a mere imitation of the target language's pronunciations. We identify three interesting learning situations which involve the target language's having different phonemic contrasts from the native language. In the first situation, the native language has neither of two sounds which contrast in the target language; in the second situation, the native language includes just one of two sounds which contrast in the target language. And in the third situation, the native language has both of the sounds in question but shows no contrast between them, i.e., a phoneme of the native language has two (or more) allophones that categorize as separate phonemes in the target language.

I Introduction

The relevance of linguistic concepts and principles for the explanation of various facts about second language (L2) acquisition has in recent years been widely discussed and debated (Alternberg and Vago, 1983; Anderson, 1987; Flynn, 1987; Ioup and Weinberger, 1987; James and Leather, 1987; White, 1989; Eubank, 1990; Major, 1990; Carlisle, 1991; Eckman, 1991; 1994; Archibald, 1993; Hoekstra and Schwartz, 1994; Yavaş, 1994). In addition, there has been a resurgence over the last few years in the attention that has been devoted to pronunciation in L2 instruction – though by common concession this aspect of language learning is seldom discussed, and often not well taught (Morley, 1987; 1991; 1994; Celce-Murcia *et al.*

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1996, Eckman and Iverson, 1996). The research we report here is intended to build an understanding of several well-known yet poorly comprehended problems relating to phonemic contrasts in the learning of L2 pronunciation. The competing influences of similarity and difference between native and target language sound systems (Flege, 1980; 1987; Wode, 1983a; Major and Kim, 1999), in particular, are central to this understanding, which we believe shows that L2 phonology is a highly abstract enterprise parallel to the phonologies of primary languages, rather than – as has often been assumed – a mere imitation of the target language's pronunciations.

We start with the assumption that in order to learn a target language the L2 learner must acquire a lexicon (a set of phonemes, morphemes and words) along with a way of combining the lexical items into larger utterances, and then pronouncing them.[1] Potential impediments to this learning arise both from certain inherent difficulties in learning the various target language phonemes, lexical items and rules, and from areas of the native language that are different from the target language, and which may therefore interfere with this acquisition.[2]

Focusing particularly on pronunciation, we can identify at least three interesting learning situations which involve the target language having different phonemic contrasts from the native language.[3] In the first, the native language has neither of the sounds which contrast in the target language. This is the case, for example, with a Korean learner acquiring the English contrast between /f/ and /v/, because Korean has neither of these sounds. The second situation is one in which the native language contains one of the phonemes which are in contrast in the target language. This is exemplified, on the one hand, by the contrast between /p/ and /f/ for Japanese learners of English because English has both of these phonemes whereas Japanese has the phoneme /p/ but lacks the sound [f], and, on the other hand, by the contrast between /š/ and /č/ for Spanish learners of English, as English contrasts both phonemes while most varieties of Spanish have /č/ but lack [š] (Zampini, 1994; 1996; 1997; Major, 1996). The third case – where

[1]For the purpose of this article, we take the subjects' ability to produce the contrasts in question as evidence for their learning the target language (TL) phonemes, though we are aware that the relationship between comprehension of TL contrasts and the ability to produce these contrasts is still being debated.

[2]An anonymous reviewer pointed out that absence also predicts difficulty. This point was first raised, to the best of our knowledge, by Lado (1957) and Stockwell & Bowen (1965). Interestingly, none of these authors ranked absence as the factor that contributed most to learning difficulty.

[3]Though L2 learners may well experience difficulty with a number of TL representations, this study focuses only on constraints involving certain phonological features.

the native language has both of the phones in question but lacks the contrast – is characterized by a phoneme of the native language having two (or more) allophones that categorize as separate phonemes in the target language. In other words, both the native language and the target language have the same relevant phones, but these constitute separate phonemes in the target language whereas they are allophones of the same phoneme in the native language. The task of the learner here is to split the two allophones into separate target language phonemes. These three language-contact situations can be depicted as in Table 1.

Table 1 Possible native language distribution for target language contrast

	Target language	Native language
1)	Sounds A and B contrast	contains neither A nor B
2)	Sounds A and B contrast	contains A, but lacks B
3)	Sounds A and B contrast	contains both A and B as allophones of the same phoneme

The most straightforward interpretation of the relative difficulty of these three types of language contact is that (1 in Table 1), where the native language has neither of the phonemes in question, would be more difficult than (2), where the native language has one of the relevant phonemes, and that (2), in turn, would be more problematic than (3), where the native language has both of the phones in question, albeit as allophones of the same phoneme. The rationale behind this conclusion is that learners should have difficulty with those target language structures that are different from the ones in the native language (Lado, 1968; Brière, 1966; 1968; Purcell and Suter, 1980; Wenk, 1986; James, 1988). It is surprising, then, that the L2 acquisition literature has long asserted – but not explained – that the situation in (3), not that in (1), causes the greatest learning difficulty (Lado, 1957; Stockwell and Bowen, 1965; Hammerly, 1982; Hardy, 1993).

A concrete example of the type of language contact identified in (3) would be a native speaker of Spanish learning the English phonemic contrast between /d/ and /ð/. In Spanish, [d] and [ð] are allophones of the same phoneme, because they are in complementary distribution: where [d] occurs, [ð] does not occur; and where [ð] occurs, [d] does not occur (Kenstowicz, 1994). Specifically, [ð] occurs following continuant segments in Spanish, and [d] occurs elsewhere; in English, on the other hand, these two sounds can occur in the same environment, as in the words *day* [de]

and *they* [ðe], and are therefore separate phonemes. Accordingly, contrasting English /d/ and /ð/ for a Spanish speaker represents the greatest learning difficulty – greater, even, than learning to acquire an entirely new phoneme, such as the phoneme /š/, which is present in English words like *she* and *push* but is completely absent in Spanish.

Lado (1957) and Stockwell and Bowen (1965) reported only anecdotal evidence for their assertion that a type (3) contact presents greater difficulty than either (1) or (2), but empirical studies performed by others have supported the claim. Thus, for example, Hammerly (1982) found that the suppression of allophones in their native language context – or the production of native language allophones in new environments – is more difficult than acquiring novel target language phonemes. Similarly, Gierut (1986) documented the difficulty of splitting native language allophones into target language phonemes in the case of a misarticulating child, as did Hardy (1993) for L2 acquisition.[4] What is particularly intriguing about these findings is that there was no explanation as to why a learning situation in which the native language and target language contain the same phones turns out to be more difficult than one in which the target language contains a contrasting phone that is completely absent in the native language. Why, in other words, does it appear to be more difficult to acquire a target language phonological structure which is relatively similar to the native language than one which is substantially different?[5]

Although no coherent explanation for this phenomenon has been forthcoming, there is a substantial literature documenting that similarities between the native language and the target language can cause problems in L2 acquisition (Oller and Ziahosseiny, 1970; Wode, 1978; 1983a; 1983b; Hecht and Mulford, 1982; Major, 1997; Young-Scholten, 1985; Flege, 1987; 1990; Bohn and Flege, 1990). Thus, Oller and Ziahosseiny (1970) proposed that learning becomes difficult whenever structures are minimally different – either in

[4]Hammerly (1982) based his analysis on data from Spanish, French and German ESL learners; Hardy's subject was a native speaker of Spanish. One could question whether the results of Gierut's subject – a misarticulating child – are relevant to our population, as did one of the anonymous reviewers. It is nevertheless interesting to note that making an allophonic split is relatively difficult regardless of the domain of learning.

[5]One of the reviewers suggests that the terminology 'allophonic split' is not appropriate, because the native language allophones are being assigned to separate TL phonemes rather than being split into separate phonemes. While we agree with the reviewer's characterization of the process, we will continue to use the term 'allophonic split', as this is what has appeared in the literature (compare Gierut, 1986; Hardy, 1993).

meaning or in form – between the native language and target language. Wode (1978; 1983a; 1983b) argued that only those target language structures that meet certain, specifiable similarity requirements can be substituted by native language structures. Those that do not meet these criteria must be acquired via developmental learning processes. Following up on this work, Flege (1987; 1990) claimed that target language sounds that are 'equivalent' or 'similar' to those in the native language are more difficult to acquire than sounds which are classified as dissimilar. In a study of the production of French [ü] (high front rounded vowel) by English speakers, Flege found that his subjects produced [ü], which is absent in English, more authentically than they did French [u] (high back rounded vowel), which – though not quite identical – does have a counterpart in English. The mechanism for this, according to Flege, is that English speakers classify the French [u] as equivalent to English [u], and as a consequence, substitute the native language sound for the target language sound, and no further learning takes place. The French [ü], on the other hand, is recognized as being distinct from English sounds, and therefore the learner attempts to acquire this pronunciation. In a similar study based on German learners of English, Bohn and Flege (1992) argued that their subjects' success or failure in learning L2 pronunciation can be explained in terms of sound correspondences between the native language and target language. And finally, Major and Kim (1999) have hypothesized that learners find it more difficult to acquire similar sounds than dissimilar sounds. The authors support their claim by showing that there is no difference between novice and experienced learners with respect to their recognition and production of dissimilar sounds, because these are acquired very quickly in the learning process, but that L2 learning experience does play a role in the production and perception of similar sounds.

In short, studies have shown that both similarities and differences between the learner's native language and the target language play a role in the explanation of L2 pronunciation. It remains necessary, however, to identify and explain the circumstances under which differences between the native language and target language are instrumental in the determination of interlanguage phonological patterns, and when instead similarities are.

We have recently conducted a number of preliminary studies bearing on similarity and difference in interlanguage phonology, exploring a small part of the broad hypothesis that the learning of an L2 sound system can be adequately described only through reference to higher order principles. Specifically, we have been

investigating the role of phonological constructs relating to phonemic contrasts in the explanation of interlanguage sound substitutions. These studies have been based on the kind of substitution phenomenon we term allophonic split, in which substitutions revolve around there being two sounds that are allophones of one phoneme in the learner's native language but which represent separate phonemes in the target language. The result of this kind of conflict between the native and target systems is a tiered stage of learning in which speakers exhibit control over the contrast first in contexts internal to the morpheme, but only later at the juncture between morphemes:

1) Allophonic split: Sounds which are allophones of one phoneme in a learner's native language constitute separate phonemes in the target language. Where the sound specified by the target language conflicts with the pattern of the native language, the target contrast is acquired first in tautomorphemic contexts, then in heteromorphemic contexts.

A second phenomenon, which grew out of our work on allophonic splits, we call 'deflected contrast'. This is a circumstance which arises when two interlanguage substitutions intersect, as schematized by the formulae in (2).

2) Deflected contrast

a. a → b in environment X __ Y (e.g., s → š__ i) (Japanese, Korean)

b. c → a (e.g., θ → s) (Japanese, Korean)

A question then arises as to what happens when the second of the statements has an opportunity to create input for the first: do both take effect so that an interlanguage lexical representation of the form /XcY/ first becomes /XaY/ by rule (2a), and then, by rule (2b), emerges as [XbY], or does the substitution pattern for /XcY/ terminate at [XaY]? The answer suggested by our findings is that substitution terminates at [XaY], i.e., the interaction of the rules is opaque, implying that the learner acts to inhibit the extent of neutralization of underlying contrasts rather than maximize the surface transparency of the rules.

A third kind of substitution, which also stemmed from our studies involving allophonic splits, may be termed 'hypercorrection of a contrast', or simply 'hypercontrast', as defined in (3) below. This phenomenon comprises a kind of substitution reversal, such that a new target language phoneme is extended into environments where – on phonetic grounds – the competing native language sound would be expected, and in fact is appropriate. We think this

represents the end point of a development in which the learner proceeds from a beginning level where no contrast between the sounds in question is made, to a second stage where the contrast develops position-sensitivity, and from there to a final stage in which the contrast is overextended into new vocabulary items.

3) Hypercontrast: One target language phoneme substitutes for another, but contradicts the native language transfer pattern.

II Allophonic split

Phoneme inventory differences have long been recognized as a source of learning difficulty, at least as far back as Lado (1957) – and as recently as Flege (1987) and Major and Kim (1999) – but a special status has been accorded to positional differences in which the allophones of a native language phoneme represent separate phonemes in the target language (Lado, 1957; Hammerly, 1982). The task of the learner in such cases is to split the native language allophones into separate target language phonemes.

Two examples of an allophonic split which we have investigated preliminarily are:

- a native speaker of Spanish learning the English distinction between /d/ and /ð/; and
- a native speaker of Korean acquiring the English contrast between /s/ and /š/.

In Spanish, [d] and [ð] are allophones of the phoneme /d/, because [ð] occurs after continuant segments and [d] occurs elsewhere; in Korean, [s] and [š] are allophones of syllable-initial /s/, because [š] occurs only before the vowel [i], [s] elsewhere. In English, of course, all of these sounds are separate phonemes, and thus a Spanish speaker learning English must learn to factor the allophones [d] and [ð] into separate phonemes, and a Korean-speaking English learner must acquire the contrast between /s/ and /š/. We have found that the splitting of native language allophones into target language phonemes potentially involves two stages which are explained by a general principle that emerged out of the theory of lexical phonology and its antecedents and which seems to have a firm basis in language learning, viz., the Derived Environment Constraint:

4) Derived Environment Constraint: Structure-preserving rule applications are restricted to derived environments.[6]

This principle presupposes that phonological rules – or constraints, under the optimality-theoretic assumption of 'harmonic serialism' (McCarthy, 2000) – fall into two groups: those that produce segments which are found in the phonemic inventory (structures which already exist in the lexicon), and those that result in novel segments which are not part of the phonemic inventory of the language. The former type of rule is known as 'structure-preserving' because it engenders substitutions among existing structures rather than create new ones. In primary languages, this kind of rule has been found to apply only to 'derived' forms, i.e., to words whose relevant portions have been modified by other rules or which are built-up out of separate meaningful elements. Rules which produce segments that are not part of the phonemic inventory, on the other hand, do not require the forms to which they apply to be derived or morphologically composite in any relevant way, and so apply 'across-the-board', within as well as between morphemes. As generalized here, the Derived Environment Constraint – which grew out of Kiparsky's (1973) pioneering of the earlier (Revised) Alternation Condition – is one of the chief discoveries in formal phonology.[7]

Quite outside the domain of phonology *per se*, surprisingly, a notable Derived Environment Constraint effect has recently been shown to obtain even in speech production. Using electro-magnetic midsagittal articulography (EMA) and electro-palatography

[6]Thus, the Derived Environment Constraint holds that structure preserving (lexical) rules may apply only to configurations that are crucially derived, as through a process of affixation. Based on the analysis of primary language data relating to rules with lexical as well as postlexical functions (specifically, Korean palatalization), Iverson (1993) makes the more general case that not only are lexical rules constrained to apply just in derived environments, as in conventional lexical phonology, but so are the applications of all structure preserving rules, whether functioning lexically or postlexically. The effect of this narrower limitation – which we adopt here as the operative version of the Derived Environment Constraint – is that neutralizing rule applications in any part of the grammar may not affect basic lexical items. Were they to do so, recovery of the underlying structure of the morpheme would be confounded, as was argued so persistently during the 'abstractness controversy' of the 1970s.

[7]As an anonymous reviewer correctly points out, our aim here is not to resuscitate the theory of Lexical Phonology. Rather, our point is that the general constraints embodied in Structure Preservation and the Lexical Derived Environment Constraint, or their implications, must be reflected in whatever theory of phonology is ultimately defensible; see, for example, Kiparsky (2000) on the need to retain lexical strata and level ordering within Optimality Theory.

(EPG), T. Cho (1999; 2001) found that Korean palatalization affecting [ti] and [ni] sequences evinces more variability in gestural timing when the sequences are heterormorphemic than when they are tautomorphemic, i.e., the coarticulation of palatalization is on average 'stronger' between morphemes, 'weaker' within. Whether the effect of the process is allophonic (/ti/ > [tʲ i] and /ni/ > [nʲ i] morpheme-internally, /n+i/ > [ɲ i] inter-morphemically) or neutralizing (/t+i/ > [tči] inter-morphemically), the articulatory extent of coronal palatalization is less when within ([tʲ i], [nʲ i]) than when between morphemes ([č i], [ɲ i]). This parallel in phonetics to the limitations of the Derived Environment Constraint is strong confirmation of the mental status of the principle, whose full manifestation is realized and recognized in the domain of phonology. Its functioning also where basic vs. derived morphological information has been thought to be fully irrelevant, in the phonetics, is thus ontologically supportive of this core principle in phonology.

At present, efforts persist to integrate the predictions of the Derived Environment Constraint into the current framework of optimality theory, which is based on interacting constraints rather than rules. The challenge to optimality theory in this connection has been to find mechanisms that implement equivalent limitations to those established in the derivational framework of lexical phonology (Kiparsky, 1982; 1985). With respect to the Derived Environment Constraint, proposals to do this have ranged from stipulated feature underspecification (Inkelas, 2000, reprising Kiparsky, 1993) and arbitrary 'constraint conjunction' (Lubowicz, 2002) to a suggestion by Y. Cho (2001) to reintroduce the 'lexical redundancy rule' first formulated by Kiparsky (1982) (compare also Anttila and Cho, 1999; Burzio, 2000). Proponents of optimality theory have thus struggled repeatedly, and continue to struggle, with accommodating the predictions of the Derived Environment Constraint. Here, we shall take this principle at face value in a derivationally oriented discussion of fundamental constructs in L2 phonology.

One of the most frequently cited examples of a rule evincing Derived Environment Constraint effects is Trisyllabic Laxing in English, so named because it has the effect of making a stressed or accented vowel short, or lax, if it is in the third syllable from the end of the word. This rule accounts for alternations in vowels such as those in the word pairs listed in (5).

5)	sane	[sén]	sanity	[sǽnəri]
	divine	[dəváɪn]	divinity	[dəvínəri]
	serene	[sərín]	serenity	[sərénəri]

The stressed vowel in each of the unsuffixed words in (5) is tense, but that same vowel is pronounced as lax when the word it is in consists of a stem followed by the two-vowel suffix *-ity*. The words in (6a) and (6b), on the other hand, illustrate that this rule applies only in so-called derived environments (i.e., when an affix has been appended, not when the word itself consists of just the stem), and the word in (6c) exemplifies that only particular suffixes (e.g., *-ity* but not *-able*) will trigger Trisyllabic Laxing.

6)	a.	stevedore	[stívədɔr]	*[stévədɔr]
	b.	nightingale	[náɪtəngel]	*[nítəngel]
	c.	notable	[nórəbəl]	*[nɔ́rəbəl]

An example of an across-the-board process not subject to the Derived Environment Constraint is Flapping in (North American) English, which accounts for the pronunciation alternations in (7).

7)	a. bet	[bɛt]	betting	[bɛrɪŋ]
	b. ride	[raɪd]	riding	[raɪrɪŋ]

Flapping is not structure preserving in that it produces the sound [ɾ], which is not part of the phonemic inventory of English. Unlike lexical rules such as Trisyllabic Laxing, moreover, Flapping is postlexical because it may apply between words (e.g., to the first [t] in *Hit it!*) as well as within single lexical entries (e.g., the noun *matter* may be pronounced the same as the comparative adjective *madder*, both with medial flaps). The distinction is one between lexical rules that apply strictly within words as they are being created, preserving structure in conformity with (4), and postlexical rules that may apply within as well as between words after they have been created, without regard for any limitations on the inventory of speech sounds.

The core idea behind the Derived Environment Constraint is thus that structure preserving operations are restricted to apply only to configurations that are derived through processes of affixation or word formation, or perhaps the application of another rule, but they may not affect basic lexical entries. If such rules were to apply to unmodified lexical items without affixes, there would be no trace left in terms of crucial alternations which support the recovery of underlying representations. As Kiparsky illustrated with respect to Finnish – to cite another case – the structure preserving rule in that language converting /t/ to [s] before /i/ crucially applies only in derived contexts, as in (8a), where processes of word

formation have brought the stem-final /t/ and the suffix /i/ into juxtaposition.

8) Finnish assibilation

a.	/halut+i/	→	[halusi]	'want-ed'
b.	/koti/	→	[koti]	'home'
c.	*[kosi]			
d.	/halut+a/	→	[haluta]	'to want'

If the /t/ plus /i/ sequence is already on hand in the basic lexical listing, on the other hand, the rule does not apply, as shown in (8b). Of course, if the rule were to apply here, producing (8c), there would be no basis for 'recovery' of the underlying /t/: Finnish speakers would never be able to figure out that the word for 'house' is [koti] if it were always pronounced as *[kosi]. The /t/ in /halut/ 'want', conversely, does undergo the change to [s] when a (suffix) /i/ follows, because this /t/ remains in other instances of the form that do not undergo the rule, as exemplified in (8d). Similarly, if the lexical Trisyllabic Laxing rule in English were to apply in nonderived contexts, i.e., within single-meaning structures like *nightingale*, there would be no basis for recovery of the fact that the first vowel in this word is /aɪ/, not /ɪ/, since the form would always be pronounced with the incorrect lax vowel.

Both structure preservation and the Derived Environment Constraint have implications for learnability. The Derived Environment Constraint is fundamentally a condition on the recoverability, or learnability, of words and their parts. Applying neutralizing rules to nonderived forms would make the lexical form of the word essentially unlearnable because there would be no alternations from which the learner could acquire the phonemic representation. Likewise, Structure Preservation – which in the tiered model of lexical phonology associates chiefly with lexical rules above the 'word level' (compare Booij and Rubach, 1987; Iverson and Salmons, 1992) and is not applicable in the postlexical component – correlates generally with the distinction between phonemic and allophonic distribution. Since postlexical rules are typically (though not exclusively) allophonic, and since lexical rules almost always result in the loss of contrast between sounds in specific environments, the long-standing distinction between distributional statements defined on phonemes and those defined on allophones is accommodated directly, reflecting the apparent primary cognitive status of the traditional phoneme. That is, a

language's inventory of phonemes is part of what must be actually learned in learning the language, along with other essentially arbitrary information encoded in the lexicon, including the particular meanings of lexical entries and their individual syntactic properties. Postlexical material, by contrast, is cognitively less prominent, presumably precisely because it lies outside the arena where meaningful contributions to word formation take place, i.e., the lexicon. This long-standing observation that phonological neutralizations, or structure preserving operations, are cognitively accessible in a way that statements of allophonic distribution are not is fundamental to the work we report on here.

Hypothesizing that Structure Preservation and the Derived Environment Constraint also govern L2 acquisition, we predict the existence of progressive stages of learning associated with the influence of a native language allophonic rule on the acquisition of the target language pronunciation. To illustrate, we reconsider the two examples of an allophonic split mentioned above (see Eckman and Iverson, 1997; 1999), namely that in Spanish [d] and [ð] are allophones of the phoneme /d/, while in Korean [s] and [š] are allophones of /s/.

In a language-contact situation in which the native language grammar incorporates a postlexical (allophonic) rule relating segments already contained in the phonemic inventory of the target language, the transfer of the native language rule to the speaker's interlanguage would not result in any change in the rule's applicational status for a learner who has not yet acquired the target language contrast. That is, the rule still is not structure preserving, and so will continue to apply in basic as well as derived environments in the interlanguage, with the learner consequently erring across-the-board on target language words containing the contrast in question. In the Spanish example, the prediction is that the learner, at Stage I, would err consistently on English words with intervocalic /d/, producing forms such as [læðər] 'ladder' and [rɛðər] 'redder' rather than [lædər] and [rɛdər]. A first-stage Korean learner of English would be predicted to err consistently on target language words containing a /si/ sequence, pronouncing *receive* as [rišiv] and the words *messy* and *meshy* both as [mɛši].

Once the learner begins to acquire the target language contrast, however, the status of the native language (postlexical) rule becomes structure preserving in the interlanguage grammar, and thus subject to the Derived Environment Constraint. This means that it now may no longer apply in all contexts, but rather is restricted to derived environments, i.e., across a morpheme boundary. In our Spanish–English example, the learner would

continue to make errors contrasting /d/ and /ð/, but would make them only in derived contexts, now pronouncing *ladder* with [d] ([lædər], non-derived context), but still producing *redder* with [ð] ([reðər], derived context). At some later point, if the learner continues to progress, we might expect this rule to be eliminated from the interlanguage altogether.

This scenario reduces to the claim that a native language postlexical rule which produces as output a target language phoneme will, if incorporated into the interlanguage grammar, observe the principles of Structure Preservation and the Derived Environment Constraint. We state this claim explicitly as the hypothesis in (9).

9) Interlanguage phonological rules conform to the principles of phonological theory.

According to (9), the predicted stages of acquisition, using a Korean learner as an example, are these:

10) Stage I, No contrast: not to make the relevant target language contrast, applying the native language rule in both derived and basic contexts (e.g., a Korean learner says the pairs *sea–she* and *messing–meshing* homophonously, as [ši] and [mɛšɪŋ]);

Stage II, Partial contrast: to make the contrast in some words, applying the native rule only in derived contexts (a Korean learner says *sea–she* correctly but errs by producing *messing–meshing* homophonously);

Stage III, Contrast: to make the contrast in all words, applying the native rule in neither derived nor basic contexts (a Korean learner says the pairs *sea-she* and *messing–meshing* correctly);

Excluded: to make the contrast in some words, applying the native rule only in basic contexts (a Korean learner says the pair *sea–she* homophonously, but says *messing–meshing* correctly).

In our view, universal principles place learnability constraints on the kinds of interlanguage grammars that can be acquired. If we are correct about this, it would be possible for a Spanish learner of English to first acquire the contrast between [d] and [ð] in only basic environments (words consisting of only a single morpheme), but it would never be possible for a learner to acquire this contrast only in derived environments. In other words, our hypothesis reduces ultimately to a learnability claim: interlanguage grammars in which [d] and [ð] are contrasted only in derived environments will never be learned.

We tested these predictions by conducting both a cross-sectional and longitudinal pilot study. The purpose of the cross-sectional

study was to test for the existence of the three predicted stages outlined in (10), and the absence of the excluded stage. Accordingly, for the hypothesis to be supported by the data from the cross-sectional study, we should attest only three kinds of learners:

- those who make the relevant contrast (between [d] and [ð] for Spanish speakers, and between [s] and [š] for Korean speakers) in both basic and derived contexts;
- those who make the relevant contrast in basic environments but who may not make the contrast in derived environments; and, finally
- those who have not yet acquired the relevant contrast in either context.

We should not find, according to the hypothesis, a learner who has the contrast in derived environments but lacks it in basic words.

The purpose of the longitudinal study was to test the two training implications of the hypothesis. It is predicted that a learner who is taught to make a phonemic split between native language allophones only in a derived environment will generalize this learning to the basic environment, but a learner who is trained to make the contrast in a basic context will not necessarily extend it to derived environments. To support these claims, it must be the case that a learner who initially lacks the contrast in both derived and basic environments and who is trained to make the contrast in only derived environments will either learn the contrast also in basic words, or will learn it in both derived and basic words. Such a learner, however, will not exhibit control over the contrast only in derived words. But a learner who is trained on the contrast in basic words alone may acquire that contrast without generalizing it to derived words.[8]

1 The cross-sectional study

We elicited pronunciations of English words from 16 English as a Second Language (ESL) learners, 9 native speakers of Spanish and 7 native speakers of Korean. Learners with these two native language backgrounds were chosen because, as outlined above, their native language includes an allophonic distribution of

[8]One of the reviewers notes that, in order for the scenario we outline to be true, the learner would have to know that 'redder' is morphologically composite. We addressed this in the protocol of the instructional study by having the subject add the suffix to the word as part of the elicitation procedure.

segments which are contrastive in English. All of the subjects were in the process of learning English as an L2. These learners ranged in age from 17 to 31, each had been in the USA for less than six months, and each was from one of the two lower modules in the University of Wisconsin – Milwaukee English as a Second Language Intensive Program. All of the subjects were paid for their participation.

The first step was to establish a baseline on each of the subjects to determine whether their interlanguage exhibited the relevant contrast: /d/ vs. /ð/ for Spanish-speaking subjects, /s/ vs. /š/ for Korean speakers (see Appendix 1). In order to accomplish this, the subjects met individually with one of the investigators and/or one of the research assistants appointed to the project. The subjects' pronunciations of words containing the sounds in question were elicited using pictures accompanied by definitions. Pictures were used to avoid the subjects' basing their pronunciation on the spelling of the words. The subjects were given directions and examples for an exercise in which they were presented with a loose-leaf notebook containing drawings depicting a word on one page, and a definition of the word on the facing page. The subjects were instructed to pronounce the word that was depicted (see Appendix 2).

The exercise was designed to elicit English words exhibiting the relevant contrast in both a derived and a basic environment. Words exhibiting the contrast in a basic environment were, monomorphemic lexical items. The words exhibiting the contrast in a derived environment contained a suffix, either the progressive 'ing' or the adjectival 'y' suffix. The exercise was constructed so that the pictures contained a cue indicating which of the two suffixes was to be added to the word being pictured. For example, if the subject was shown a picture of some grass on one page, and a definition of grass on the facing page, the subject was to produce the word *grass*. If the picture and definition presented to the subject also contained the cue 'adjective' on the page below the picture and the definition, then the subject was to produce the adjectival form of *grass*, namely, *grassy*. Thus, the subjects produced two kinds of baseline words, those containing the sounds in question in a basic context, i.e., without a suffix added, and those with the sound in a derived context, i.e., with the addition of a suffix.

The protocol stipulated that only subjects who lacked the contrast in both the basic and derived environments were to be entered into the instructional study. Accordingly, any subject who had the contrast in question in at least one of the environments became part of the cross-sectional study, the purpose of which was to attest only the predicted stages in (10).

All of the seven Korean subjects achieved accuracy of 80% or better over the contrast between /s/ and /š/ in basic contexts, thus meeting, in this environment, the performance criterion we established for having acquired the contrast. As graphed in a previous report by Eckman *et al.* (2001), and summarized in Table 2,[9] three of the Koreans were Stage III learners who evinced the contrast in both derived and basic environments, whereas four showed the contrast only in basic contexts during the initial baseline measures but shortly thereafter evidenced it in derived environments as well. Two Spanish-speaking subjects were also entered into the cross-sectional study, both of whom were Stage III learners who exhibited the /d/–/ð/ contrast in derived as well as basic environments. In sum, then, all of the results from the cross-sectional study depict interlanguage grammars that are at either Stage II, having the relevant contrast in only basic environments, or Stage III, evincing the contrast in both derived and basic contexts. None of the interlanguage grammars we analyzed showed the contrast only in derived environments. Therefore, all of the results from the cross-sectional study are in conformity with the hypothesis of (9) and the staging laid out in (10).

2 *The instructional study*

Subjects who lacked the relevant contrast in both derived and basic contexts, based on the baseline probes, were entered into the instructional study. As there were no Stage I Korean subjects, all 7 of the subjects in the instructional study were Spanish speakers. The subjects who were entered into the instructional study were trained on the relevant contrasts using a single-subject design (McReynolds and Kearns, 1983). Thus, the hypothesis we are testing is claimed to hold for all learners, not just for the mean of a group (in which individual patterns may be masked). And there are several ways in which a subject's performance can be in compliance with the hypothesis, whether trained on the contrast in derived environments only or basic environments only: subjects would support the hypothesis if they:

- acquired the contrast only in the basic environment;
- learned the contrast in both derived and basic contexts; or
- did not acquire the contrast in either environment.

[9]Selected portions of the data reported in Tables 2–6, which are comprehensive, are presented graphically in Eckman *et al.*, 2001.

Table 2 Baselines scores (in percentages) of the seven Korean and two Spanish subjects at Stage II or Stage III

Subject	Environment	Scores		
		1	2	3
K1	Basic	96	100	100
	Derived	86	100	100
K2	Basic	100	98	100
	Derived	92	92	100
K3	Basic	88	88	89
	Derived	88	83	92
K4	Basic	94	90	85
	Derived	48	50	63
K5	Basic	93	94	90
	Derived	60	73	100
K6	Basic	90	77	85
	Derived	81	50	100
K7	Basic	91	88	88
	Derived	64	90	75
S1	Basic	94	88	90
	Derived	94	78	83
S2	Basic	89	74	86
	Derived	100	90	100

Pooling such data from a group study could obscure the fact that the data support the hypothesis, especially if the data reflect all three of these situations.

The baseline established the starting point for each subject with respect to the relevant contrast. As indicated, only those subjects who did not reach criterion on the contrast in the baseline words were entered into the training study. Subjects were randomly assigned to one of two training conditions: either the subject was trained using nonce words exhibiting the contrast only in basic environments, or the subject was trained on nonce words showing the contrast only in derived environments. Nonce words were used for training to ensure that all subjects were equal with respect to their knowledge of the training words; that is, none of the subjects knew any of the training words at the outset. The subjects were given directions at the beginning of training that the exercise required them to produce words on the basis of a picture and a definition, as was the case with the baseline words (see Appendix 3). However, in the instructional study, the directions informed the subjects that the words used in the exercise were not real words of English, but had been made up for the purposes of this exercise (see Appendix 4).

The specific type of single-subject design used for the instructional study was a staggered, multiple baseline design (McReynolds and Kearns, 1983) in which 3 subjects were entered into one training

condition and 4 subjects were entered into the other. Each successive subject in a given condition was administered one additional baseline measure. More specifically, 3 subjects (S3, S4 and S5) received training on the /d/–/ð/ contrast in only derived environments (as presented in Table 3) while 4 subjects (S6, S7, S8 and S9) were trained on the contrast in only basic environments. Subjects S4 and S5 are considered direct replications of S3's treatment. Therefore, S3's baseline was established over 2 sessions, while the baselines for S4 and S5 were established over 3 and 4 sessions, respectively. The procedure was identical with the other training group: S6's baseline was established over 2 sessions, with an additional baseline measure added to the baseline of each additional, replicating subject, meaning that S9's baseline consisted of five measures. The baselines for the 7 subjects entered into the training study are shown in Table 3.

It was hypothesized that the subjects would generalize the contrast learned on the basis of the training words (i.e., the nonce words) to the baseline words. In fact, the subjects' performance on the baseline words provides the test of the hypothesis, because it was predicted that subjects who were trained only on nonce words exhibiting the contrast in derived environments would generalize this contrast to the baseline words and evince the contrast in both basic and derived environments. It was further hypothesized that subjects trained only on nonce words exhibiting the contrast in basic environments would not necessarily generalize the contrast to derived environments in the baseline words.

The results of the training for subjects S3, S4 and S5, who were

Table 3 Baselines scores (in percentages) of the seven Spanish subjects at Stage I

Subject	Environment	Scores				
		1	2	3	4	5
S3	Basic	68	75			
	Derived	67	77			
S4	Basic	76	68	65		
	Derived	72	75	50		
S5	Basic	77	67	58	71	
	Derived	72	77	58	67	
S6	Basic	72	65			
	Derived	78	73			
S7	Basic	77	78	77		
	Derived	50	58	50		
S8	Basic	71	69	71	65	
	Derived	72	59	68	64	
S9	Basic	76	76	66	70	79
	Derived	65	45	64	36	54

trained on the distinction between /d/ and /ð/ using words containing the contrast only in derived environments, are shown in Table 4. Subject S3 acquired the contrast in both basic and derived environments at about the same time, but S4 and S5 proceeded through distinct stages. These results are particularly interesting because, although trained on the contrast only in derived contexts, S4 generalized the training first to baseline words in basic positions, and only subsequently to derived environments. Subject S5, on the other hand, implemented the contrast in basic environments but not in derived contexts.

Stated differently, S3 responded to the training by quickly becoming a Stage III learner. S4 first passed through Stage II, where she had the contrast only in basic contexts, before becoming a Stage III learner. S5 became a Stage II learner, and did not generalize the contrast to derived environments in the baseline words despite having been instructed only on derived-environment training words. All 3 of these outcomes are permissible under the hypothesis.

Subjects S6 through S9 were trained in the basic condition, the results of which are shown in Table 5. S6 generalized the contrast

Table 4 Scores (in percentages) of the during-training baseline probes of the three Spanish subjects trained in the derived-environment condition

Subject	Environment	Scores over time								
		1	2	3	4	5	6	7	8	9
S3	Basic	81	78	82	93	92				
	Derived	67	92	85	92	94				
S4	Basic	75	76	72	95	95	95			
	Derived	75	42	67	50	88	100			
S5	Basic	71	67	68	70	67	84	77	80	81
	Derived	50	50	50	50	75	58	61	61	67

Table 5 Scores (in percentages) of the during-training baseline probes of the four Spanish subjects trained in the basic-environment condition

Subject	Environment	Scores over time								
		1	2	3	4	5	6	7	8	9
S6	Basic	73	89	94	100					
	Derived	73	97	100	100					
S7	Basic	71	67	68	70	80	80	90	93	90
	Derived	50	58	50	42	50	73	58	63	92
S8	Basic	70	79	71	80	80				
	Derived	36	54	41	50	50				
S9	Basic	81	78	82	93	92				
	Derived	67	92	85	92	94				

from basic to derived contexts, an outcome which, while not expected, is nevertheless allowed by the hypothesis. The results from S7 are especially noteworthy. She acquired the contrast in basic environments on the baseline words by the fifth during-training baseline probe, but did not acquire the contrast in derived environments until the ninth such baseline probe, some 10 weeks later. Thus, S7 clearly evidences an acquisition sequence in which she acquired the contrast first in lexically basic environments and then, more than 2 months later, also in derived environments. Subject S8 acquired the contrast in the basic environments in which she was trained, but did not generalize the contrast to derived environments. And S9 acquired the contrast in both environments at the same time, as was the case with S6.

Our training of Stage I subjects, then, produced learners who were either Stage II or Stage III, while not producing any learners whose interlanguage grammar is excluded by the hypothesis in (9). All of these outcomes provide support for our claims, with the results from S4, S5, S7 and S8 being supportive in particularly interesting ways. Results from this training study thus suggest that splitting native language allophones into separate target language phonemes entails significantly more than learning to pronounce new sounds. Specifically, the acquisition of a target language contrast where none exists in the native language appears to be governed by general principles which constrain the acquisition to proceed through only some of the logically possible stages of learning. That is, target language contrasts between native language allophones seem to be incorporated into interlanguages progressively, not at once, and the progression seems to follow a path which is laid out by the interaction of two very general considerations: Structure Preservation and the Derived Environment Constraint.

III Deflected contrast

In what we term 'deflected contrast', two interlanguage substitutions potentially intersect but there is systematic blocking of one of the substitutions. We have been able to document at least three examples of this phenomenon. First, with respect to the palatalization of /s/ described above in connection with Korean learners, there is systematic failure of palatalization to occur when the [s] derives from another substitution. In Korean, as well as in Japanese and many other languages, English interdental fricatives

present an articulatory challenge that is typically met through the substitution of /s/ for /θ/, as in a learner's rendering of *thank* as *sank*. But for these same speakers, a target language word in which /θ/ appears before /ɪ/, such as *think*, emerges either with /θ/ (as in the target-like [θɪŋk]) or with /s/ ([sɪŋk]), but never with [š] (*[šɪŋk]. Thus, the learner continues to maintain the target language distinction between /θ/ and /s/, but the contrast is deflected such that *think* is pronounced [sɪŋk], while *sink* is pronounced [šɪŋk].

Using a picture-naming task similar to that outlined in the previous section, we elicited target language words containing segments [s] and [θ]. A number of words contained word-initial [s] before various vowels, including the high front vowel of *seed* and *seal*. The purpose of these forms was to determine if the subject would palatalize the [s], following the allophonic pattern of the native language. A number of other words contained an initial [θ] before various vowels, including [ɪ]. Examples include *thumb*, *thaw*, *thank*, *theme* and *think*. Approximately half of the words elicited were distracters, containing neither [s] nor [θ]. A deflected contrast would be evinced in these cases if the subject systematically substituted [š] for [s] before the high front vowel, as in [šid] for *seed*, while also substituting [s] for [θ] before a high front vowel, as in [sɪn] for *thin*.

We attested deflected contrast in the interaction of these substitutions with one Korean subject, who palatalized [s] to [š] before high front vowels while also substituting [s] in some words where [θ] was obligated. In particular, the subject substituted [s] for [θ] in the word *theme*, but did not palatalize this [s]; thus, he regularly rendered *theme* as [sim], not *[šim]. This deflected contrast has also been attested by Dinnsen and Barlow (1998) in the speech of some misarticulating children in first language acquisition.

A striking exemplification of the phenomenon in L2 acquisition occurs among Japanese learners of English, who also commonly render *thank* with [s] ([saŋk]) and *sink* with [š] ([šɪŋk]). Japanese thus parallels Korean in its native language exclusion of [θ] and in the distribution of [s] vs. [š], employing the latter before [i], the former elsewhere. Hence Japanese speakers producing [saŋk] for *thank* and [šɪŋk] for *sink* evince deflected contrast of the interaction between [θ]-to-[s] substitution and [s]-to-[š] palatalization when they render *think* as [sɪŋk] rather than merge it with their pronunciation of *sink* [šɪŋk]. Particularly revealing is the recurrent pronunciation by one of our Japanese consultants of the word *sympathy* as [šɪmpasi], not – in the form that simple direct transfer of native language phonetic patterns would imply – as [šɪmpaši]. A

multiply challenging phrase such as *sympathy theory* would be uttered as [šɪmpasi siri], not *[šɪmpaši šɪri], palatalizing only the basic /s/, not the derived /s/'s corresponding to target /θ/ as well.

Our other examples of deflected contrast come from subjects whose native language is Spanish. In many Latin American varieties of Spanish, [s] and [z] are in complementary distribution, with [z] occurring before voiced consonants, as in *mismo* [mizmo] 'same', and [s] occurring elsewhere (Zampini, 1996; 1997); additionally, the common substitute for English [θ] is [s] (*tooth* = [tus]). We elicited pronunciations of target language compound words in which, for some forms, underlying /s/ was placed adjacent to a voiced consonant, as in *chessboard*, and in other words a target language [θ] was placed next to a voiced consonant, as in *mathbook*. We attested the deflected contrast with three Spanish subjects. During the same session, these three learners systematically voiced [s] before voiced consonants, and also substituted [s] in some words where [θ] was obligated. For example, they substituted [s] for [θ] in the word *clothbag*, but did not voice this [s], pronouncing the word as [klɔsbæk], not *[klɔzbæk].

The deflected contrast which ensues from interactional opacity demonstrates that L2 pronunciation is not simply a matter of obeying the phonetic constraints of the native language, or simply of mimicking target language sounds. The overriding principle here seems to be one of maintenance of a contrast or, perhaps more appropriately, the prevention of the complete neutralization of a contrast. In the case of the Korean speakers, the goal is to distinguish three target language phonemes: /s/, /š/ and /θ/; for the Spanish speakers, the target language contrast holds among /s/, /z/ and /θ/. In both instances, the transparent implementation of all relevant substitutions would neutralize a three-way contrast (to /š/ for the Korean speakers, to /z/ for the Spanish speakers). The blocking of one of the substitutions in such cases deflects contrasts away from the total neutralization called for by the phonetics, and so evidences the play of more abstract forces.

IV Hypercontrast

The third phenomenon deriving from our studies on allophonic splits consists in overgeneralizations, or hypercorrections, in which a learner errs on a newly-acquired contrast by substituting the wrong member of the phonemic pair, a phenomenon we term 'hypercontrast'. Our data come from 5 of the Korean subjects who were involved in the study on splitting native language allophones into separate target language phonemes. According to that protocol,

only subjects who lacked the relevant contrast in both derived and basic environments were to be entered into the instructional study, but there turned out to be no Stage I Koreans. Nevertheless, out of general curiosity, 5 of the Korean subjects were also entered into the training phase of the study, and were given instruction on the /s/–/š/ contrast using nonce words. Subjects K1, K2 and K4 were instructed with words showing the contrast in basic environments, and subjects K3 and K5 were trained on the contrast only in derived environments, summarized in Table 6.

Table 6 Scores (in percentages) of the native language errors and hypercorrection errors for five Korean subjects

Subject	Error type	Scores over time								
		1	2	3	4	5	6	7	8	9
K1	NL	0	0	0	0	10	13	33	39	42
	Hypercorrect	30	85	92	88	36	57	43	39	29
K2	NL	25	51	24	11	8	20	4	4	6
	Hypercorrect	51	23	31	25	13	30	4	0	6
K3	NL	48	22	14	21	3				
	Hypercorrect	13	9	7	9	9				
K4	NL	75	59	34	7	22				
	Hypercorrect	0	1	7	24	10				
K5	NL	25	9	15	0	0				
	Hypercorrect	15	5	0	0	0				

In the first four training sessions K1 produced only hypercorrections (incorrect [s] for correct [š]), and no errors in the direction of the native language pattern ([š] for target [s]). But in later sessions K1 exhibited a sharp decline in the incidence of hypercorrect errors (presumably concomitant with his learning of these new words) as the influence of the native language pattern began to emerge, producing more and more instances of incorrect [š] before [i]. This increase in native language interference is surprising in view of the subject's previous performance on the training words, which showed no native language interference at all.

The situation with Subject K2 runs parallel. K2 begins by producing a majority of errors (51%) by substituting [s] for [š] before the vowel [i], while he produces far fewer errors (25%) in the other direction, substituting [š] for [s] before [i]. By the second session, the situation has reversed itself, and K2 is erring on about 50% of words containing [s] before [i] and on about 25% of words with [š] in that environment. Thus, during the first session, K2 pronounced correctly only 49% of the training words containing [š] before [i], while he pronounced correctly 75% of the words

containing [s] before [i]. Both error types then gradually decline over the course of training, but it is nevertheless interesting that the error pattern in the initial session is the emergence of the error in which a word requiring [š] before [i], which is the native language pattern, is wrongly produced with [s]. Moreover, this error type occurred at least as frequently as the native language pattern.

The behaviour of the other three subjects is a bit different, but still instructive. K3 erred initially on 48% of the training words in the direction of the native language pattern, producing [š] where the target is [s], and this declined rapidly to near zero over the next 4 sessions as [s] substituted for [š] steadily at around the 10% level in the pattern characteristic of hypercorrection. K4's performance showed an initial preponderance of native language error patterns, but this gradually declined and merged with a pattern of hypercorrection errors at around the 10–20% level. Subject K5's hypercontrast profile began with a relatively small percentage of both interference and hypercontrast errors, both of which then trailed off to zero over the next few sessions.

What appears to be consistent across all 5 of these subjects is that:

- They all exhibit the /s/–/š/ contrast in actual words;
- They all produce hypercorrections in nonce words, more so in earlier as compared to later training sessions.

Indeed, having learned the contrast in question would seem to be a prerequisite to the production of hypercorrections in the first place, for without productive control of the contrast the subject would have no basis for producing [s] for the required, and natively motivated, [š].

We also attested examples of hypercorrection for the Spanish-speaking subjects in the instructional study, though this type of error for the Spanish subjects was less numerous, presumably because by virtue of being enrolled in the instructional study these subjects lacked the relevant contrast, which is apparently a prerequisite to hyper-correction. For the Spanish speakers, then, the hypercorrect pattern of errors involved production of [d] for [ð] in environments where the native language would require [ð], causing them to produce the nonce word [diso] as [ðiso].

The hypercontrasts themselves, we believe, are motivated by speakers' awareness of past errors they have made based on the native language pattern, in the Korean case the substitution of interlanguage [š] for target language [s] before [i]. The insecurity attending this awareness sensitizes them to their performance in

new words, and recognition of the target-language-inappropriateness of the native language pattern results in suppression of the rule or constraint that had been the source of their errors in the past. The idea here at this stage of acquisition in second language phonology, i.e., after a contrast has been learned in actual words but before it is fully mastered in novel environments, is that a competition exists between the native language pattern of distribution and that which results from its suppression via implementation of a newly learned target language phoneme. Hypercontrast, then, consists in the overgeneralization that all – not just some – instances of the sequence [si] are inappropriate in the target language.

Our data show, moreover, that this competition between contrary strategies is resolved to begin with in favour of hypercorrected productions, and strongly so. Later, as realization becomes apparent that the hypercontrast approach is no more appropriate than is the pattern presented by the native language, the two strategies coexist for a period, reflecting the confusion that such contradictions naturally cause. At the end stage, when the new words are no longer new and have been properly lexicalized, the conflicting strategies appear to neutralize each other, resulting in the words' being produced with correct rather than either hypercorrect or interference-based sounds. Still, the two strategies presumably remain available, at least latently, to begin the cycle again when confronted with other new words and other novel production requirements.

Our preliminary investigations have also uncovered hypercontrast responses in cases where the native language contains just one of two target language sounds, as, for example, in attempts to distinguish English /p/ and /f/ on the part of Korean learners. Unlike the [š]–[s] sound pair, both of which occur in Korean (albeit as allophones of the same phoneme), Korean does not have the sound [f] at all, and so it may be expected that Korean performance on words like *fork* and *muffin* would be subject to interference errors, with native [p] substituting for target [f]. This indeed was the case among several of our Korean consultants; but two of them also exhibited a substantial number of errors on English words like *pie* and *soapy*, substituting target [f] for target [p] even though [p], but not [f], is an extant sound of the native language. These additional instances of hypercontrast under conditions rather different from those identified above suggest that further investigation of the phenomenon is well warranted.

V Summary

We have investigated three kinds of sound substitutions in L2 acquisition, all of which support the claim that certain facts about the pattern of interlanguage phonological development and interference can be accounted for through the principles of phonological theory. We have further suggested that these principles can be linked explicitly to conditions of learnability, showing, in particular, that target language contrasts between native language allophones are incorporated into interlanguages progressively, not at once, and that the progression follows a path which is laid out by the interaction of two very general phonological considerations: the Derived Environment Constraint and Structure Preservation. Thus, the perhaps most basic of phonological abstractions – the familiar notion of contrast – appears to be introduced into L2 acquisition in a progressive and predictable way.

We have also reported on studies indicating that the acquisition of L2 phonological contrasts involves structured generalization as well as overgeneralization. The former is a familiar grammatical notion, and observes principles of grammar that have been uncovered in the analysis of primary languages. The latter is familiar from work on primary languages as well, in the study of sociolinguistic variation, but to our knowledge has not been well documented in the literature on L2 learning. Together, these patterns of generalization and overgeneralization along with the staged progression of allophonic split show interlanguage to be cut from the same grammatical cloth as any other natural language.

VI Implications

The chief principle that we see at play in the acquisition of L2 phonemic contrasts, to recapitulate, is the Derived Environment Constraint as expressed in (4), itself a modernized resuscitation of the Revised Alternation Condition (Kiparsky, 1993). Phonology these days is widely practised as a 'constraint' rather than 'rule' based enterprise, however, and thus it is instructive to see how the learnability and derived environment effects uncovered here in L2 phonology might be incorporated into the context of optimality theory.

Optimality theory rests on a series of ranked, violable constraints whose interaction leads to the selection of the 'optimal candidate' from among an open set of possible realizations of the underlying representation. This now familiar model is sharply challenged by derivational properties that are theoretically unavailable to it,

'opacity' in particular. A variety of fixes (in addition to 'sympathy theory'; see Itô and Mester, 2001) have been put forward in order to accommodate the kind of interaction which for L2 phonologies we have termed 'deflected contrast' (see Section III above), i.e., the superficial contradiction of one grammatical statement via the invocation of another. The credibility of these modifications to the theory still awaits assessment, but it is clear as well that derived environment effects are quite beyond the capacity of classical optimal theory to capture. The only effort, to our knowledge, to bring this major finding of modern phonological inquiry into the fold of optimality theory is that of Lubowicz (2002).

Lubowicz reviews the (first) palatalization of velars in Polish, noting that palatalization takes place in morphologically derived environments (/xemik+ek/ → [xemiček] 'chemist-diminutive') but not in morpheme internal contexts ([k'isiel] 'jelly'). This classic derived environment effect cannot be characterized within conventional optimality theory, however. Lubowicz (2002: 25) writes:

> Since there are instances of velars that do not palatalize before front vowels, the markedness constraint calling for palatalization, PAL, must be ranked below a faithfulness constraint militating against a change in coronality, IDENT(coronal). This is shown in (11) [her (56)].
>
> 11) IDENT(coronal) >> PAL
>
> But with this ranking, there should be no palatalization whatsoever.

Lubowicz proposes to imbue optimality theory with the descriptive equivalent of the derived environment effect in morphologically composite environments via the mechanism of 'local conjunction'. This device marries a markedness constraint, such as PAL, with a faithfulness constraint, in this case the correspondence constraint guarding stem:syllable anchoring. The idea behind stem:syllable anchoring is that the edge segments of a morphological stem should 'align with' the edges of its syllables. And there typically is a violation of stem:syllable anchoring when a palatalization-inducing vowel is appended as a suffix to a consonant final stem (because of resyllabification, the syllable edge no longer lines up with the edge of the stem). This violation can be exploited, Lubowicz argues, to capture the morphological derived environment effect if the stem:syllable anchoring constraint is conjoined with the palatalization constraint. The right-anchoring correspondence constraint is as in (12); locally conjoined with palatalization, its ranking relative to the others is as in (13).

12) R-ANCHOR(Stem;σ) – the rightmost segment of a stem in the input has a correspondent at the right edge of a syllable in the output.

13) $[\text{PAL and R-ANCHOR(Stem;}\sigma)]_{\text{AdjacentSegments}}$ >> IDENT(coronal) >> PAL

The theory then provides for the special interpretation that a violation of stem:syllable anchoring will activate its local conjunct, viz., palatalization. When anchoring is not violated, however, palatalization is not activated and remains subordinate to the identity faithfulness constraint. Hence, palatalization takes place in morphologically derived contexts (because stem:syllable anchoring is violated, triggering a locally conjoined markedness constraint), but palatalization does not take place in tautomorphemic environments (because no violation of anchoring occurs to trigger the markedness constraint).

This arrangement is not quite the same as to invoke the Derived Environment Constraint, however. Apart from the technicalities of local conjunction and just how the violation of a correspondence constraint is construed to activate a markedness constraint, the chief difference between the two approaches is that the specification of local conjunction is a language-specific matter, whereas the Derived Environment Constraint is proposed to hold for all cases, in all languages, without being specified for any individual grammar. This is a very substantial difference, of course, sufficient in itself to justify the universally constrained derivational approach over its local conjunction competitors.

Still, it might be useful to see how this modification of optimality theory would attempt to accommodate the staging of L2 phonological learning laid out in (10) for Korean learners of English. Assuming a markedness constraint PAL_{K} militating against sequences of /si/, it is clear that PAL_{K} must be ranked superior to IDENT(anterior) (an identity faithfulness constraint calling for anterior segments to be realized as anterior), because in Korean /s/ palatalizes before /i/ both within and between morphemes, i.e., across the board. This is the ranking given in (14).

14) PAL_{K} >> IDENT(anterior)

Presumably this would be the ranking of constraints which Stage I learners of English convey to their interlanguage grammars, producing pairs *sea–she* as [ši] and *messing-meshing* as [mɛšɪŋ]. Stage III learners would have learned to suppress palatalization altogether, yielding the reverse ranking in (15) and so producing the fricatives in *sea–she* and *messing–meshing* as they are in the English target language.

15) IDENT(anterior) >> PAL_K

Stage II learners, by contrast, evince a derived environment effect with respect to interlanguage palatalization. They pronounce the pair *sea–she* correctly, but continue to palatalize in *messing*, merging it with *meshing*. For speakers at this stage of learning, the local conjunction version of optimality theory would arrange constraints as in (16).

16) $[PAL_K \text{ and } \text{R-ANCHOR(Stem;}\sigma)]_{AdjacentSegments}$ >> IDENT(anterior) >> PAL_K

This would operate analogously to Polish, then, in the manner Lubowicz describes. The question, however, is by what mechanism of learning did Stage II learners acquire the locally conjoined palatalization/anchoring constraint? Merely listening to the comprehensible input of ambient target speakers is not sufficient to motivate it, for first-language speakers of English do not palatalize /s/ either in *sea* or *messing*. Nor is there any sense in which (16) represents a generalization or simplification of the native language pattern of constraints as expressed in (16) – rather, it is a complication, with repeated specification of the markedness constraint PAL_K, once before the faithfulness constraint IDENT(anterior) and once after it.

Indeed, the issue is even more complex when it is taken into account that Korean also palatalizes coronal stops before /i/ in the next morpheme (Iverson, 1993). But this is a neutralizing process in the language and for that apparent reason is restricted to derived environments, as the phonemic stop-affricate distributions in (17a–c) show in comparison with the allophonic fricative pattern of (17d).

17) a.	/tat-/	'close'	[tat͡t'a]	(indicative)	[taǰi]	(noun)
	/tot-/	'rise'	[tot͡t'a]	(indicative)	[toǰ]	(noun)
	/pat^h-/	'field'	[pat^{h}ɯl]	(objective)	[pač^{h}i]	(subject)
b.	[madi]	'knot' (</mati/)		c.	[čip͡]	'house'
	[pət^{h}i]	'endure'			[č'iǰə]	'tear' (imperative)
	[t^{h}i]	'dust'			[čiǰə]	'bark' (imperative)
d.	/os-/	'cloth'	[osɯl]	(object)	[ošɨ]	(subject)
	[ši]		'poem'	*[si]		
	[šikan]	'time'	*[sikan]			
	[š'i]	'seed'	*[s'i]			

It thus turns out that a constellation of optimality theoretic constraints as in (16) would in fact be appropriate for Korean, but only for the cases in which the effect of palatalization is neutralizing. For all other cases – i.e., when it is allophonic – the requisite configuration would have to be as in (14), and it is far from obvious how a constraint grammar could accommodate this distinction, with ranking one way in cases where the effect is allophonic, but with superordinate local conjunction of a correspondence constraint and a suppressed markedness constraint in cases where the effect is neutralizing. The derivational approach, on the other hand, takes note of the universality of the Derived Environment Constraint given in (4), and recognizes but one palatalization process whose varying restricted and across-the-board effects are predicted by the principle, not stipulated via multiple rankings, which in any event would have to be sensitive to the neutralizing vs. allophonic character of their outputs.

What is crucially missing from this characterization of optimality theory as enriched by local conjunction, clearly, is the notion of phonemic contrast. Contrast is an integral element of Structure Preservation and the Derived Environment Constraint, principles which we see governing the phonological grammars of both primary and secondary languages. These principles, up to this point, have been expressible only within a constraint-sensitive derivational variety of phonological description, which thus remains the empirically superior alternative until such general principles can be integrated into the constraints-only framework of optimality theory.

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Appendix 1 Baseline words and training words

Baseline probe: /d/–/ð/ (native language = Spanish)

1. bathe
2. door
3. doctor
4. bride
5. mother
6. father
7. bread
8. audience
9. dollar
10. bed
11. dish
12. puddle
13. smooth
14. ladder
15. saddle
16. head
17. ride
18. riding
19. cloud
20. cloudy
21. sunbathe
22. sun bathing
23. leather
24. wood
25. bathing
26. grade
27. grading
28. dog food
29. grandmother
30. read
31. reading
32. brothers
33. medicine
34. they
35. them

Baseline probe: /s/–/š/ (native language = Korean)

1. suitcase
2. she
3. sink
4. bicycle
5. eat
6. eating
7. crash
8. crashing
9. race
10. fat
11. write
12. soccer
13. racing
14. fish
15. sun
16. motorcycle
17. fishing
18. mouse
29. message
30. toothbrush
31. teacher
32. bus
33. brushing
34. dish
35. dress
36. shoes
37. tissues
38. dressy
39. seats
40. vacation
41. brush
42. shirt
43. mess
44. messy
45. shade
46. essay

19. mice
20. chest
21. fatty
22. writing
23. parachute
24. grass
25. chicken
26. grassy
27. scissors
28. patient
47. sea
48. ocean
49. skate
50. skating
51. washing
52. house
53. wash
54. sick
55. shorts
56. seat

Training words for /d/–/ð/ in a derived environment (native language = Spanish)

1. [dodɪŋ]
2. [miðɪŋ]
3. [guði]
4. [faydɪŋ]
5. [bawdi]
6. [gudi]
7. [fayðɪŋ]
8. [čɛdi]
9. [bawði]
10. [čɛði]
11. [doðɪŋ]
12. [midɪŋ]

Training words for /d/–/ð/ in a nonderived environment (native language = Spanish)

1. [dodi]
2. [nide]
3. [čod]
4. [daka]
5. [doði]
6. [ðiso]
7. [bawd]
8. [niðe]
9. [diso]
10. [bawð]
11. [ðaka]
12. [čoð]

Training words for /s/–/š/ in a derived environment (native language = Korean)

1. [disɪŋ]
2. [nɛ̆si]
3. [kusɪŋ]
4. [poši]
5. [nɛ̆si]
6. [bawšɪŋ]
7. [posi]
8. [dišɪŋ]
9. [geši]
10. [bawsɪŋ]
11. [kuši]
12. [gesɪŋ]

Training words for /s/–/š/ in a nonderived environment (native language = Korean)

1. [šiyo]
2. [teši]
3. [tæš]
4. [moši]
5. [sima]
6. [tesi]
7. [koš]
8. [siyo]
9. [mosi]
10. [kos]
11. [šima]
12. [tæs]

Appendix 2 Directions for baseline words

In this exercise, we are asking you to produce a word. We will show you a picture which represents the word on one page, and show you a definition of the word on the other page. You should look at both the picture and the definition and then say the word that goes with them.

There are two kinds of words that we will ask you to say. In many cases, the word will not contain any suffixes or prefixes. For example, if the word we want you to say is 'woman' or 'television',

we will show you a picture of a woman on one page and a definition of a woman on the other page. We will do the same with a word such as 'television'.

In some cases, the word that we want you to say contains a suffix, either 'ing' for the progressive form of the verb, or 'y' which changes the word into an adjective. For example, the word 'fishing' contains the progressive suffix, 'ing'. If we want you to say the word 'fishing', we will show you a picture that represents the word and also contains:

\+
progressive

On the opposite page, we will give you a definition of the word also followed by:

\+
progressive

In this case, you simply say the word 'fishing'.

The other suffix that we will ask you to add to the word is 'y', which changes a word into an adjective. For example, if we want you to say the word 'grassy', we will show you a picture that represents the word 'grass' and also contains:

\+
adjective

On the opposite page, we will give you a definition of the word 'grass' also followed by:

\+
adjective

Appendix 3 Directions for training words: derived-environment condition

In this exercise, as we did in the first exercise, we are asking you to produce a word. The words that we want you to say, this time, all contain a suffix: either 'ing' for the progressive form of the verb, or 'y' which changes the word into an adjective. However, in this exercise, all of the words are nonce words, that is, they are not real words of English, but instead they have been made up for the

purposes of this exercise.

In the first step of the exercise, we will show you a picture which represents the word on one page, and show you a definition of the word on the other page. We will then tell you what the word is that goes with the picture and the definition. You should look at both the picture and the definition and then repeat the word that goes with them.

For example, the word in question may be 'dapping', which contains the progressive suffix, 'ing'. On one page, we will show you a picture that represents the word and also contains

\+
progressive

On the opposite page, we will give you a definition of the word also followed by

\+
progressive

We will then tell you that the nonce word is 'dap', in which case you add the suffix to the word and say 'dapping'.

The other suffix that we will ask you to add to the word is 'y', which changes a word into an adjective. For example, if we want you to say the word 'toky', we will show you a picture that represents the word and also contains

\+
adjective

On the opposite page, we will give you a definition of the word also followed by

\+
adjective

We will then tell you that the word is 'tok', in which case you add the 'y' suffix and say 'toky'.

We will repeat this exercise several times. There is a total of twelve words; please try to learn which word goes with each picture and with each definition, because in the second step of the exercise, we will ask you to produce the word from the picture only, or from the definition only.

Appendix 4 Directions for training words: nonderived environment condition

In this exercise, as we did in the first exercise, we are asking you to produce a word. However, in this case, the word is a nonce word, that is, it is not a real word of English, but instead it has been made up for the purposes of this exercise. In the first step of the exercise, we will show you a picture which represents the word on one page, and show you a definition of the word on the other page. We will then tell you what the word is that goes with the picture and the definition. You should look at both the picture and the definition and then repeat the word that goes with them.

We will repeat this exercise several times. There is a total of twelve words; please try to learn which word goes with each picture and with each definition, because in the second step of the exercise, we will ask you to produce the word from the picture only, or from the definition only.