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CHAPTER 29

EMERGENCE OF THE UNMARKED IN INDIAN ENGLISHES WITH DIFFERENT SUBSTRATES*

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1. Introduction

Current phonological theory stresses the important role of markedness in synchronic phonological alternations and in acquisition. Sounds, sequences, or structures are considered more marked than others based on a variety of criteria, such as whether they are more difficult to pronounce, less common, more unnatural, or acquired later (Trubetzkoy 1931/1971). In Optimality Theory (OT) (Prince and Smolensky 1993), markedness constraints play a major role in determining an output, as they compete with constraints on correspondence to input or to related forms. Sometimes markedness constraints are ranked high and win, forcing violations of correspondence to the input so that a less marked output is chosen as the winner. However, even when a markedness constraint is generally overruled by correspondence constraints within a language, there may be circumstances in which correspondence is not active, as in epenthetic vowels which have no input to correspond to. In such cases, markedness has been

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found to play a role beyond that which we find to hold true in the general surface phonotactics of the language; this more subtle appearance of markedness has been called The Emergence of The Unmarked or TETU (McCarthy and Prince 1994).

Second language (L2) acquisition has revealed another kind of emergence of the unmarked, as learners attempt to learn new constructions not present in their first language (L1). The interaction of the L1 grammar with novel types of input forms may also result in TETU. For example, Broselow *et al.* (1998) show that when speakers of an L1 with no obstruent codas (Mandarin) attempt to produce output forms with obstruent codas in the L2 (English), they produce the less marked voiceless obstruents more successfully than the more marked voiced obstruents. While numerous factors interact simultaneously in the acquisition of a second language, including the patterns of the first language (L1), the patterns of the target language (L2), and the amount and type of exposure to the L2, we thus see that markedness also plays a major role in second language acquisition. OT accounts have been generated for the three main factors in L2 acquisition: transfer, markedness, and input frequency (e.g., Barlow 2005; Broselow *et al.* 1998; Broselow and Xu 2004; Hancin-Bhatt and Bhatt 1997; Hansen 2004; Obiala 2008; Peng and Ann 2004; Steele 2002).

English is primarily learned as a second language in India and provides a fertile field for seeking the emergence of the unmarked. Indian learners of English might speak any one of a huge number of L1s in India: the 2001 Census lists 13 languages with over 10 million speakers each, and the total number of languages in the country is conservatively estimated in the hundreds. These L1s can differ widely in their phonotactic constraints, while the target L2 (Indian English) remains approximately the same. Because of this diversity of L1 phonotactics and the relative unity of the L2 target, variations in L2 Indian Englishes from different L1 speakers will let us test the success of the OT approach.

In this chapter, I examine data from five Indian L1s. I focus on the phonotactics of word-final consonants and consonant clusters, which, in Indian English, are relatively freely permitted. The five L1s, on the other hand, have various constraints on which consonants and clusters are permitted word-finally. We should expect that variation in L2 Indian Englishes should result from both transfer of L1 phonotactics and the emergence of the unmarked. Transfer will be accounted for within OT by the assumption that L2 learners begin with their L1 ranking; TETU results emerge when the L1 grammar gives no evidence for the ranking of a markedness constraint, but the L2 input forces the markedness constraint to assert its presence (Broselow *et al.* 1998; Hancin-Bhatt and Bhatt 1997). If the L2 contains more marked structures than those allowed in the L1, TETU effects should arise.

I find that L2 Indian English speakers' productions of voiced final obstruents depended heavily on transfer from their L1 and the emergence of the unmarked, with voiceless obstruents prevailing for speakers of the L1 that did not allow any word-final obstruents. The production of final consonant clusters also revealed the effects of markedness and transfer, but, in addition, suggests that L2 speakers of English treat final clusters ending in /s/ as special, just like L1 speakers. Applying the Gradual Learning Algorithm (Boersma 1997; Boersma and Hayes 2001) helps to illustrate that the special treatment of /s/ in clusters cannot result from frequency alone, supporting the claim that C + /s/ clusters should be treated as special in L2 as well as L1 phonology (Yildiz 2005).

I begin with a description of the L1s of the speakers, the speakers' backgrounds, and the data collected, in Section 2. Section 3 presents the results in terms of single consonants and clusters produced word finally, followed by an analysis within Optimality Theory in Section 4. Finally, in Section 5, I model learning of this data, using the Gradual Learning Algorithm to evaluate frequency effects, and Section 6 concludes with a discussion of how data from Indian English(es) provides us with a window for testing models of Second Language Acquisition and the relative roles of markedness and frequency.

2. Data: L1s, speakers, and data collection

2.1 L1s and their Speakers

Data was gathered in Hyderabad, India, from five speakers each of five Indian L1s: Ao, Angami, Mizo, Gujarati, and Hindi; all twenty-five were also proficient speakers of Indian English, using it at the university level on a daily basis. These five languages belong to two distinct language families: Indo-Aryan (Gujarati and Hindi) and Tibeto-Burman (Ao, Angami, and Mizo). As shown in Figure 29.1, the Indo-Aryan languages are spoken in the north central part of the country, while the Tibeto-Burman languages are spoken in the north-east part, in the states of Nagaland and Mizoram.

Indo-Aryan languages are distantly related to English and have comparable phonotactics for word-final consonants and consonant clusters (Kachru 2006; Mistry 1997; Ohala 1999; Vyas 2011). Both Gujarati and Hindi allow full contrast of voiced and voiceless obstruents in final position, although both tend to limit final clusters to two consonants, while Indian English allows up to four. Tibeto-Burman languages require much simpler syllable structure. Angami allows CV syllables only, with no final consonants or clusters (Ravindran 1974). Mizo and Ao each allow only a single consonant word-finally, limited to either a sonorant or a voiceless obstruent (Chhangte 1986; Coupe 2003; Gurubasave-Gowda 1972; Lalrindiki 1992; Wiltshire 2005). While the target, General Indian English, is not monolithic, standard varieties of Indian English do generally allow the same consonants and clusters word-finally as other varieties of English such as British or American (CIEFL 1972; Pandey 1981). The phonotactics of word-final consonants in these different languages can be summarized as in Table 29.1.

Although Indian English also has phonotactic constraints on acceptable consonants and clusters in onsets, and sometimes allows more complex onsets than the L1s of these speakers, none of the speakers had any difficulty producing initial consonant clusters correctly. Therefore, I focus on the word final consonants and consonant clusters in the discussion below.

FIGURE 29.1 The five L1s of the subjects and the locations where they are spoken.

Table 29.1 Word-final consonant phonotactics of L1s and Indian English

L1s	Angami	Mizo	Ao	Gujarati	Hindi	Indian English
Allows final C	no	yes	yes	yes	yes	yes
Allows final voiced obstruent	no	no	no	yes	yes	yes
Allows final CC	no	no	no	yes	yes	yes

The 25 participants were recorded in Hyderabad, India, where they were attending colleges or universities whose medium of instruction was English. All were between ages 18–28, and most were 22–25; there was an approximate balance between male/female (11/14). All used their L1 at home, at least until moving to Hyderabad for school, and most continued to use their L1s with friends from the same background. They had similar levels of education in English, having begun in nursery or at the beginning of school (ages 3–5), and having attended English medium school. Teachers of English in Indian schools can come from a variety of places within India, but there is a 'standard General Indian English' norm that is taught (CIEFL 1972; Pandey 1981). Most had at least one parent who spoke English, and all were exposed to media in a variety of English L1 and L2 varieties. I chose the age range of 18–28 since such speakers were experienced enough to be proficient in Indian English, and young enough that the endo-normative standard had been established before they began their schooling.

2.2 Data Collection

The subjects were asked to read a word list, sentences, and a short paragraph at their own pace, and were allowed time to prepare if they wished, in order to elicit the greatest level of accuracy in production of which they felt capable. The interviewer who provided instructions and answered questions was a speaker of Indian English, to try to reduce accommodation to the American English speaking author. The word list contained 95 words; the sentences included 156 short sentences, and the short paragraph passage was the 'Please call Stella' paragraph, used with permission from the George Mason University Speech Accent Archive. In general, both word list and sentences were designed for evaluating the segmental inventories and any phonotactic limitations on consonant clusters in various position (word-initial and word-final), while the paragraph provided segmental characteristics in connected speech.

The stimuli were recorded on a DAT recorder and transferred via a CSL computer for analysis (sampling rate = 44.1 kHz). Transcriptions were made by one phonetically-trained researcher of isolated words, keywords from isolated sentences and dialogues, and the short passage. Eighteen distinct word-final single consonant targets were examined, which included voiced and voiceless obstruents and voiced sonorants, as shown in Table 29.2. Note that General Indian English generally uses dental stops [t̪ʰ] and [d̪] where inner circle varieties tend to have fricatives [θ] and [ð]; therefore, these are classed as targeted stops rather than fricatives. Speakers of different L1s tend to treat the alveolar stops of English differently, some producing alveolars [t] and [d] and others retroflexes [ʈ] and [ɖ; hence these are listed together within a row. If the type of sound occurred in more than one word in the data, the number of occurrences of that sound which each speaker would produce is provided in parentheses.

Twenty-eight word-final cluster targets were also examined; Table 29.3 provides these grouped into eight types, including six types of two consonant clusters (CC) and two types of three consonant clusters (CCC). The CC consisted of nasal-stop, lateral-stop, lateral-nasal, fricative-stop, stop-/s/, and stop-stop. The CCC were classed as CC plus /s/ vs. CC plus stop.

Table 29.2 Word-final consonant targets, types and tokens, examined for each L1 group

Word-final Consonants	Types (and # words if > 1)	Tokens (per L1 group)
Voiceless stops & affricate	p (2), t̪, t/ʈ (3), ʧ, k (2)	45
Voiced stops & affricate	b (2), ɖ (3), ʤ, g (3)	45
Voiceless fricatives	f, s (4), ʃ	30
Voiced fricatives[10]	v (2), z (4)	30
Sonorants	l, m, n, ŋ	20
Totals	18 types	170 tokens

Table 29.3 Word-final clusters, types and tokens, examined for each L1 group

Word-final Clusters	Types (and # words if > 1)	Tokens (per L1 group)
Nasal-stop	mp, nt/ɳʈ (2), nʤ, nd/ɳɖ (2)	30
Lateral-stop	lt (2), ld, lp	20
Lateral-nasal	lm	5
Fricative stop	st (2), sk, ʃt	20
Stop-s	ps, t̪s, ʈs, bz, dz, gz	30
Stop-stop	pt (2), kt (2)	20
CC-s	lts, mps, nts, fts, sks, sts, kts	35
CC-stop	lpt, kst	10
Totals	28 types	170 tokens

3. Results

All speakers produced single sonorants (not included here) and voiceless obstruents (stops, fricatives, and affricate from Table 29.2) consistently and correctly in word-final position, including the Angami speakers whose first language allows no coda consonants at all. The productions of voiced obstruents and clusters proved to distinguish the speaker groups based on their L1 phonotactics.

When attempting the voiced stops, voiced affricate, and voiced fricatives, the Tibeto-Burman speakers tended to devoice far more often than the speakers of Gujarati and Hindi (see Table 29.4). Remember that the Tibeto-Burman languages either allow no codas (Angami) or allow obstruents only if they are voiceless (Ao, Mizo), while the Indo-Aryan languages do allow voiced obstruents in their codas. While even Gujarati and Hindi speakers

Table 29.4 Production of word-final voiced obstruents in Indian English, by L1 groups

Target (# tokens per L1)	Angami	Ao	Mizo	Gujarati	Hindi
Voiced stops (45)	5	8	9	43	45
Voiceless	39	37	36	1	0
Deleted	1	0	0	0	0
Voiced fricatives (30)	0	2	0	15	17
Voiceless	29	28	30	13	13
Deleted	1	0	0	2	0
% voiceless: stops	87%	82%	80%	2%	0
% voiceless: fricatives	97%	93%	100%	43%	43%
% voiceless: overall	91%	87%	88%	19%	17%

Table 29.5 Word-final cluster reductions in Indian English, by L1 groups

Cluster (# tokens per L1)	Angami	Ao	Mizo	Gujarati	Hindi
Nasal-stop (30)	2	1	4	2	0
Lateral-stop (20)	2	2	4	1	1
Lateral-nasal (5)	1	2	3	2	0
Fricative-stop (20)	7	3	9	2	1
Stop-s (30)	0	0	2	2	0
Stop-stop (20)	9	9	13	2	1
CC-s (35)	18	15	20	12	5
CC-stop (10)	3	3	7	2	0
Totals	42	38	62	25	8
% altered (out of 170)	24.7%	20.6%	36.5%	14.7%	4.7%

do devoice sometimes, their overall averages are not far from Edge's (1991) finding that native speakers of English, performing similar tasks, devoice 2–16% of target voiced stops.

Note that all groups of speakers have a higher percentage of devoicing for fricatives than for stops; this is true even in languages which allow neither fricatives nor stops in word-final position, as well as for languages which allow both.

The realization of target consonant clusters also differs based on L1, with speakers of languages which do not allow clusters (Angami, Ao, Mizo) deleting consonants more often than speakers of languages which do allow clusters (Gujarati, Hindi), as shown in Table 29.5. However, not all types of clusters were treated equally. Nasal-stop clusters and stop-fricative clusters were commonly produced accurately in all L1s, while clusters of two stops were more often reduced.[1]

4. Analysis

An OT analysis requires us to formalize constraints on markedness and correspondence to input, which are in competition with each other. The priorities of a specific language are determined by the ranking of these constraints. A common assumption about L1 acquisition is that learners begin with the markedness constraints ranked above correspondence; this fits with our assumptions about child grammar beginning with the least marked utterances and gradually learning to sacrifice markedness in order to be faithful to the input of the L1 (Gnanadesikan 1996; Rose 2000; Smolensky 1996). Languages do not always provide a reason to rerank constraints, and we assume constraints do not move unless forced by some data. This will be important in explaining some of the TETU effects below.

4.1 Rankings in OT

As with the results section, I begin with an analysis of the single final consonants, and then move to the clusters. Final consonants are subject to markedness constraints, which must limit the presence and type of consonants allowed in the coda. Cross-linguistically, it is more marked to have a coda consonant than to be an open syllable. If a coda consonant is present, sonorant consonants are less marked than obstruents. Of the obstruents, voiceless consonants are less marked. These statements translate into the widely used constraints (1a)–(1c) below (e.g., Kager 1999):

(1) Markedness:

a.	*CODA:	A syllable does not end in a consonant.
b.	*OBSCODA:	A syllable does not end in an obstruent.
c.	*VDOBSCODA:	A syllable does not end in a voiced obstruent.
d.	*VDFRICCODA:	A syllable does not end in a voiced fricative

Constraint (1d) is less common, and requires some justification. Markedness constraints are usually justified by reference to phonetic, typology, child acquisition, or implicational statements, such as 'all languages which allow CVC syllables also allow CV syllables', which motivates (1a). Constraint (1d) would be justified if voiced fricatives are even more marked than voiced stops in syllable-final position. Vaux (1998) proposes that fricatives are [+spread glottis], which makes the combination of [+voice, +spread glottis] phonetically marked, as Beckman *et al.* (2006) note that it is difficult to maintain the airflow required for oral turbulence while simultaneously voicing. Steele (2002), in addition to noting that voicing in fricatives "may well present greater articulatory difficulty than voicing in stops', makes the typological observation that there are languages in which 'while stops contrast for voicing, fricatives are uniquely voiceless' (2002: 126).

Tableau 29.1 Markedness constraints evaluating candidate outputs

Candidate Outputs	*CODA	*OBSCODA	*VDOBSCODA	*VDFRICCODA
[bi]				
[bim]	*			
[bit]	*	*		
[bis]	*	*		
[bid]	*	*	*	
[biz]	*	*	*	*

Phonological markedness for voiced fricatives is also supported by languages such as Dutch, in which assimilation of word internal clusters results in voiced obstruents (stops and fricatives) in codas only when followed by a voiced stop in the onset; in other obstruent clusters, the presence of a fricative results in the cluster being produced as voiceless (Kager 1999). Constraint (1d) is further justified by the increase in devoicing found among target fricatives over stops produced by the speakers of various L1s in our data.

To provide an example of how these constraints are evaluated, consider Tableau 29.1. In the left column, candidates for realization as an output are listed, while the constraints are listed across the top row. Normally, the highest ranked constraint is listed towards the left and lower candidates towards the right. If a candidate violates a constraint, an asterisk is placed in the column of that constraint. In Tableau 29.1, the first candidate, [bi] violates none of the markedness constraints, while the second candidate, [bim], violates only *CODA. The third and fourth candidates, [bit] and [bis], violate *OBSCODA, as well as *CODA, since their coda consonants [t] and [s] are obstruents. As they are voiceless obstruents they do not violate the final two constraints. However, the fifth candidate [bid] violates not only *CODA and *OBSCODA, but also *VDOBSCODA as well, while the final candidate, [biz], violates all four constraints.

Simply violating constraints does not make a candidate a winner or loser, however. Markedness constraints are in competition with correspondence constraints, which require an output to resemble its input in some specific way. The correspondence constraint in (2a) preserves the relationship between voicing values in the input and output forms, while constraint (2b) penalizes deletion and constraint (2c) penalizes epenthesis.

(2) Correspondence:[2]

a.	IDENT-IO(voice):	Corresponding input and output segments match in [±voice]
b.	MAX-IO(C):	A consonant in input is present in output (no deletion).
c.	DEP-IO(V):	A vowel in output is present in input (no epenthesis)

Tableau 29.2 Correspondence constraints evaluating candidate outputs

Input /biz/	IDENT(voice)	MAX(C)	DEP(V)
[biz]			
[bis]	*		
[bi]		*	
[bizi]			*

Similar to Tableau 29.1, we can illustrate the evaluation of these correspondence constraints independent of all other constraints; in the case of correspondence constraints, however, it is important to know what the input form is. This is traditionally given in the upper left hand corner, as in Tableau 29.2.

Given the input /biz/, the only output that is fully faithful and violates none of the constraints from (2) is [biz]. Candidate [bis] violates IDENT(voice): because the final consonant differs in voicing from the input consonant; candidate [bi] violates MAX(C) because the final consonant has been deleted, and candidate [bizi] violates DEP(V) because a vowel appears in the output that was not present in the input. Although such candidates are unfaithful, they may be chosen as the best output in a language which values or ranks some markedness constraints above the correspondence constraints being violated.

4.2 Ranking for Single Consonants Word-finally

In order to formulate an analysis of the interaction between transfer and the emergence of the unmarked in Optimality Theory, we need to compare the grammars of the L1s with the grammars of their L2s. We assume that when learning an L1, the constraint ranking begins with all markedness constraints outranking all correspondence constraints (Gnanadesikan 1996; Rose 2000; Smolensky 1996); when learning an L2, the constraint ranking begins from the ranking of the L1.

The grammar of the target English allows voiced obstruents in the coda, including voiced fricatives, and therefore requires the correspondence constraints to outrank the markedness constraints provided above. That is, as shown in (3), English speakers have learned to rank all the above correspondence constraints higher than the markedness constraints, which will make an input like /biz/ result in an output like [biz], despite its violations of all four markedness constraints.

(3) IDENT(voice), MAX(C), DEP(V) >> *CODA,*OBSCODA, *VDOBSCODA, *VDFRICCODA

An OT account of transfer involves using the L1 ranking of speakers as the starting points for learning the target L2 ranking. In languages like Hindi and Gujarati, which follow the same pattern as the L2 target in allowing voiced obstruents, including voiced stops and voiced fricatives, to appear in coda position, we expect that their L1 ranking also places markedness below the correspondence constraints. With their grammar identical to that of the target, we expect positive transfer to result in productions similar to English speakers, which is what we find, for the most part.[3]

The L1 grammars of Ao and Mizo speakers, on the other hand, allow coda consonants, including obstruents, but any coda obstruents must be voiceless. In order to allow obstruent codas in their L1 grammar, speakers have learned that the correspondence constraints must outrank the markedness constraints *Coda,*ObsCoda. As their languages do not allow voiced obstruents or fricatives in coda positions, two markedness constraints remain at the top of the ranking, above correspondence. This means that the markedness and correspondence constraints are interleaved in their L1 grammars, as in (4):

(4) *VdObsCoda, *VdFricCoda>> Ident(voice), Max(C), Dep(V) >> *Coda,*ObsCoda

The input forms of Ao and Mizo may not provide any synchronic evidence from alternations, of what would happen to an input containing a voiced obstruent in coda position; however, input forms in English do. The production of English final voiced obstruents as generally voiceless reveals that the speakers apply their L1 grammar to their L2, and with the markedness constraints *VdObsCoda, *VdFricCoda sitting at the top of the ranking, we would predict that any voiced obstruents in input would surface as voiceless. Comparing the prediction to the data presented in Table 29.4, which shows rampant devoicing of obstruents for these speakers, we find the prediction holds. Thus, both the Ao and Mizo production of most obstruents as voiceless, and the Hindi and Gujarati production of a contrast between voiced and voiceless obstruents, can be predicted by the interpretation of transfer as an application of the L1 ranking to an L2.[4]

The final grammar, that of Angami, allows no codas at all. In the L1 ranking, the constraint against codas (*Coda) will mask any effects of other markedness constraints on the kind of consonants in the coda (*ObsCoda, *VdObsCoda, *VdFricCoda). However, since we assume that markedness constraints outrank correspondence constraints in the initial state (Gnanadesikan 1996; Smolensky 1996), and that no reranking occurs without positive evidence, then the L1 grammar will have to remain in its initial state:

(5) *Coda,*ObsCoda, *VdObsCoda, *VdFricCoda >> Ident(voice), Max(C), Dep-IO(V)

This is the opposite of the grammar provided for English, in which correspondence outranked markedness. Angami speakers have mastered production of sonorant codas and single voiceless obstruent codas, suggesting that they have altered their L1 grammar towards that of their L2 by lowering two of the markedness constraints, *Coda,*ObsCoda, below the correspondence constraints, a ranking which results in Tableau 29.3:

Tableau 29.3 Ranking for obstruent devoicing

Input /biz/	*VdObsCoda, *VdFricCoda	Max(c), Dep(v)	Ident(voice)	*Coda,*ObsCoda
[biz]	**			*
[bi]		*		
[bizi]		*		
☞ [bis]			*	*

(6) *VdObsCoda, *VdFricCoda >> Ident(voice), Max(C), Dep(V) >> *Coda,*ObsCoda

As Angami speakers did not have any evidence from their own L1 for which types of obstruents should be preferred/banned from codas, the devoicing of obstruents found in their results in Table 29.4 cannot be attributed to direct transfer as in Mizo and Ao. Instead, it results from the original unchanged ranking of markedness constraints above correspondence constraints, coupled with the learned demotion of the constraints against codas in general and obstruent codas in particular, as a result of learning English. Note that, as in Tableau 29.1, a coda of any kind violates *Coda, leading to the expectation that it would be demoted first; an obstruent of any kind, voiced or voiceless, stop or fricative, violates *ObsCoda, leading to the expectation that it would be demoted second fastest. These demotions revealed the presence of the remaining high ranking *VdObsCoda, *VdFricCoda constraints in the grammar of their L2 Indian English, an emergence of the unmarked effect. A similar example of the emergence of the unmarked is analyzed in Broselow *et al.* (1998), which drew on similar data for speakers of Mandarin Chinese L1.

Thus, transfer and the emergence of the unmarked combined can, for the most part, account for the high rate of obstruent devoicing for speakers of L1s which allow either no codas at all or obstruents only if voiceless. An additional observation here is the higher rate of voicelessness among fricatives than stops, which supports the introduction of the additional markedness constraint, *VdFricCoda.[5]

4.3 Ranking for Consonant Clusters Word-finally

As above with single consonants in the coda, both transfer and universal markedness may predict some of the results when clusters of consonants in the coda are the target. In addition to being evaluated for markedness in terms of voicing, coda consonants and consonant clusters can be evaluated for their markedness in terms of sonority. Hancin-Bhatt and Bhatt (1997) argue that a combination of universal constraints on sonority and constraint rankings transferred from L1 can be used to predict patterns of L2 learners in producing new clusters.

Cross-linguistically, onset consonants that are less sonorous, and coda consonants that are more sonorous, are less marked, on a sonority scale such as:

(7) Sonority Scale
(More sonorous) Glide > Lateral > Nasal > Fricative > Stop (less sonorous)

In addition, sequences of consonants in the coda should be limited by constraints on the number of consonants, the slope of sonority within the cluster, and the distance in sonority between members of the cluster (Selkirk 1984; Steriade 1982).

(8) Markedness for consonant clusters:

*ComplexCoda:	No consonant clusters in Coda.
SonSeq:	Consonant clusters fall in sonority in the coda.
MSD:	Consonants in the coda differ in sonority by a minimum of 2 steps.[6]

As before, the markedness constraints will be assumed to outrank correspondence constraints (from (2) above), in the initial state. With such a ranking, we would expect clusters of consonants in codas to be repaired by epenthetic vowels (DepV violations) or deletion of one of the consonants (MaxC violations) in the output. Ao, Angami, and Mizo, which allow no coda clusters at all, are predicted to retain this ranking in their L1 grammars, as learners have no reason to rerank any markedness constraints.

(9) Markedness outranks Correspondence in the Angami, Ao, and Mizo L1 grammars
*ComplexCoda, SonSeq, MSD >> Max(C), Dep(V)

If a learner acquires an L1 which allows clusters, some or all of the above markedness constraints will need to move lower than correspondence, allowing input clusters of consonants to surface unchanged. If all markedness constraints are lower, all clusters will be produced faithfully. If only some are lowered, or with markedness interleaved with correspondence, we expect some clusters to be repaired, and others to be produced faithfully. Hindi and Gujarati, which allow complex codas, must demote at least *ComplexCoda in their L1 grammars. Such a ranking would leave coda clusters subject to constraints on sonority sequencing and distance, but not rule them out altogether.

(10) Markedness and Correspondence interleaved in the Gujarati and Hindi L1 grammars
SonSeq, MSD >> Max(C), Dep(V) >> *ComplexCoda

Transfer of the L1 rankings in (9) and (10) directly into L2 English productions would predict that Angami, Ao, and Mizo speakers will repair consonant clusters of all kinds, while Hindi and Gujarati speakers will repair only the more marked clusters. On the other hand, if Angami, Ao and Mizo speakers begin their learning by lowering *COMPLEXCODA,[7] they may first be able to produce the less marked clusters, those which satisfy SONSEQ and MSD, thus producing another TETU effect. That is, the existence of SONSEQ and MSD constraints were obscured within the L1 grammars by the high ranking of *COMPLEXCODA but lowering it reveals that these other markedness constraints are universally present and available to be applied to new inputs.

As Table 29.5 reveals, speakers of L1s that lack complex codas did delete consonants from a greater number of target clusters, from 20.6% for Ao speakers up to 36.5% for Mizo speakers; Hindi and Gujarati speakers had much lower rates of deletion, at 4.7% and 14.7%, respectively. Looking more closely at which clusters were simplified shows that those clusters which were most marked for sonority sequencing, such as stop + stop, or sonority distance, such as lateral + nasal, were most likely to be reduced; while those which were well formed, such as nasal + stop, were rarely subject to deletion. Thus both groups show the effects of high ranking SONSEQ, MSD constraints.

However, the predictions of the markedness constraints and the order of acquisition do not match perfectly. Fricatives are generally treated as higher in sonority than stops. Therefore, fricative + stop clusters, which show a decline in sonority and thus obey SONSEQ, should be less marked than stop + fricative clusters, which have a rise in sonority. However, speakers of Indian English, regardless of their L1, tended to produce stop + fricative clusters correctly more often than fricative + stop.[8]

(11) Markedness of two-consonant clusters by sonority sequencing and the MSD:

Least Marked			Most Marked
NS, LS	**FS**	**SF**	SS

Two-consonant cluster acquisition order by speakers of Indian English:

First/Best			Last/Worst
NS, LS	**SF**	**FS**	SS

The fricative in question in the stop + fricative cluster was generally /s/ or /z/. Osburne (1996) noted that her subject, an L1 speaker of Vietnamese, tended to produce English clusters violating the hierarchy correctly more often (28.7%) than those following it (4.7%); most of the clusters correctly produced despite being considered to violate the hierarchy were 'two adjacent stops (-kt, -pt) or a stop followed by a fricative (-ts, ndz)' (Osburne 1996: 173). She suggests possible reasons are the inflectional status of the final consonant or its orthographic salience. In the data analyzed here, however, the final /s/ or /z/ was never a separate morpheme, unlike Osburne (1996).

Two further potential explanations come to mind. Either the sonority sequencing constraint does not count stop + /s/ as a markedness violation, or some other factor outweighs the sonority violation. Frequency plays a role in L1 acquisition (Zamuner *et al.* 2005), so perhaps the frequency of stop + /s/ clusters in English provided learners with more practice and opportunities to master it. I will consider the role of frequency in the following section, where it can be tested using a learning algorithm.

Is it plausible that stop + /s/ might simply not count as a sonority sequencing violation? The finding here is similar to that of Kirk and Demuth (2005) for 2-year-old children acquiring English, who were more accurate in producing nasal + /z/ and stop + /s/ clusters prior to other clusters. Kirk and Demuth reject a frequency solution, and attribute their finding to the articulatory ease of production for word-final fricatives. Ease of production suggests that word-final clusters ending in /s/ are less marked than other clusters. There are a variety of representational approaches for making the claim that these sequences are structurally distinct from other clusters. For example, excess consonants word-finally have been treated as an appendix or extraprosodic (e.g., Fudge 1969; Goldsmith 1990; Itô 1986) or as the onset of an empty headed syllable in government phonology (Kaye *et al.* 1990); in either case, the /s/ is put outside of coda position and hence beyond the reach of the sonority sequencing constraints on codas. For onsets, it has also been argued that the reverse sequence, /s/ + stop, should not be considered less marked (Morelli 1999), or even that /s/ + stop clusters should be treated as a single complex segment in English onsets (Yildiz 2005).

The relative roles of frequency and markedness will be examined using the gradual learning algorithm in the following section.

5. Modeling learning in OT using the GLA

Standard Optimality Theory required strict domination in ranking; if one constraint ranked higher than another, then it always overruled the lower ranked constraint. A Stochastic OT model, proposed in Boersma (1997), Boersma and Levelt (1999), and Boersma and Hayes (2001), provides each constraint with a range of rankings and allows each constraint to overlap with others.

(12) [Constraint 1]
    [Constraint 2] [Constraint 3]

At each time of utterance, the exact ranking value of a constraint falls somewhere within its range, determined stochastically. Constraints 1 and 2 will always dominate Constraint 3, but for the first two constraints, the ranking may vary; it is more likely that Constraint 1 will outrank Constraint 2, but on some occasions, Constraint 2 will rank higher. This allows for variability in outputs; for example, when some but not all final obstruents are devoiced, the constraints *VdObsCoda, *VdFricCoda and Ident(voice) may overlap in their ranking.

Built within this Stochastic OT model is an algorithm for modeling learning, the Gradual Learning Algorithm or GLA. The learning algorithm is error-driven, comparing the form that the grammar currently generates with an actual input-output pair, and changing the ranking if it has generated an error. The change in ranking is modest; hence, learning is gradual. Furthermore, the input-output pairs can be weighted to represent the frequency with which the learner would encounter the forms, to determine the impact of frequency on the course of learning. Fortunately, the GLA can be modeled in Praat (Boersma and Weenink 2003). The GLA has been applied to L1 learning, but can be easily made suitable for modeling L2 learning. The initial ranking values of the constraints can be prespecified, and for an L2 learner they can be specified as the ranking values from the L1 grammar. The algorithm can also be stopped during the learning process (as in Boersma and Levelt 1999), to investigate the output distributions of a learner who has not completed learning.

5.1 Modeling Single Consonants and Devoicing

Using the markedness and correspondence constraints from Section 4.2, I created L1 grammars with ranking values 20 points apart where there were rankings of strict domination, and equal ranking where there were tied or unranked constraints. There were three basic grammars: the Gujarati and Hindi L1s in which correspondence ranked high, the Ao and Mizo rankings which interleaved markedness and correspondence to allow obstruent codas only if voiceless, and the Angami ranking with all markedness constraints ranked higher than all correspondence constraints. I then applied the L1 rankings to input-output pairs from English, including with voiced obstruent codas, and started the model learning. The algorithm predicted the orders of acquisition which we found in our speakers:

(13) Sonorant codas before obstruent codas (Angami)
Voiceless obstruent codas before voiced obstruent codas (Angami, Ao, Mizo)
Voiced stop codas before voiced fricative codas (all L1s)

If we tell the model to ignore transfer and begin with the constraints equally ranked and using the same input-output pairs, we find that it predicts errors which the speakers did not make, such as extensive devoicing for the Hindi and Gujarati speakers.[9] Because speakers of Hindi and Gujarati have already demoted some markedness constraints in their L1 ranking before beginning L2 learning, they avoid these outputs.

5.2 Modeling Cluster Simplification

Similarly to the case with devoicing, beginning the learning algorithm using L1 rankings as the initial state results in different expectations for outputs from speakers of the different L1s. Angami, Ao, and Mizo speakers, who have all coda constraints ranked high, produce more deletions in all clusters than Hindi and Gujarati speakers, who begin with an L1 ranking that has already demoted *ComplexCoda below correspondence. Also as with the devoicing example, beginning with the constraints unranked or with identical rankings of Markedness >> Correspondence in all L1s does not distinguish the groups by L1. Given that the results show differences in cluster production, again the data provides support for the OT modeling of transfer as learning an L2 based on the use of the L1 ranking as a starting point.

As all L1 groups have a high ranking of the SONSEQ and MSD constraints, all speakers should acquire:

(14) Nasal + Stop before Fricative + Stop
Lateral + Stop before Fricative + Stop
Fricative + Stop before Stop + Stop

These results accord with the data in Table 29.5. The learning model was also run several times in order to explore the question of learning to produce stop-/s/ clusters fully while still deleting a consonant from /s/-stop clusters. The input-output pairs provided to the learning model first treated the constraint SONSEQ as violated by stop-/s/ clusters and satisfied by /s/-stop clusters, in accordance with the standard relative sonority values of stops and /s/. However, regardless of the initial ranking of the various constraints, the GLA would not acquire stop-/s/ before /s/-stop clusters.

If stop-/s/ is more marked in terms of sonority sequencing, might it still be learned more quickly since it is a common word-final morpheme in English (present tense, plural)? That is, one possible explanation which the GLA model allows us to test is that frequency in input-output pairs might affect order of acquisition. Broselow and Xu (2004), for example, make a similar suggestion for L2 learners, and test the hypothesis using the GLA; however, their targets to be acquired violated distinct markedness constraints. In this case, we are comparing order of acquisition of two clusters which differ on a single constraint, and ask whether a more marked cluster may be acquired first based on frequency alone. Accordingly, I provided the model with an estimate of relative frequency, based on Kirk and Demuth (2005), who examined two corpora of child directed speech, and found an estimated frequency ratio of stop-/s/ to /s/-stop of 4:1. Provided with four times as frequent stop-/s/ clusters in the learning data, the GLA was unable to produce stop-/s/ faster than /s/ stop. Exaggerating the frequency ratio to 100:1 did not succeed either. Thus to the question of whether a cluster that is more frequent but also more marked on a single constraint can be learned faster than a less marked cluster, according to the GLA, the answer is no. These findings confirm the results of Jarosz (2010), who shows that in first language acquisition, frequency can determine acquisition order only to the extent that markedness allows.

This leaves us with two options. One is that the GLA does not sufficiently capture the effect of frequency on learning. A second option is that stop + /s/ clusters are not more marked than /s/ + stop clusters in word-final position. As previously discussed, this second option is one that has been proposed repeatedly in other contexts within phonology, treating the word-final /s/ as external to the word-final coda or special in its status, so that it cannot count as a violation of coda sonority sequencing. If the GLA uses constraints which consider stop + /s/ as no more marked than /s/ + stop, and use data in which stop + /s/ is more frequent, then it correctly learns stop + /s/ clusters first.

6. Discussion and Conclusions

This study suffers from some obvious limitations: the relatively small number of speakers from each L1, the limited amount of data gathered, and the limited type of data—all read—rather than a variety of styles. Future studies with larger sets of speakers and more varied data would be welcome, to test the generalizations found here. Further questions that also might be investigated are the role of the input, in particular, perception of the L2 input by speakers of various L1s (Broselow and Xu 2004; Steriade 2001). If the L1 lacks a voicing contrast in coda obstruents, speakers may not be able to perceive the contrast robustly in L2. Future research might include measuring speakers' perception, as well as simulating interference from inaccurate perception when learning.

However this study has also made several contributions. In an OT account, L1 learners and L2 learners differ primarily in their initial state: the L1 learners begin with all markedness constraints ranked above all correspondence constraints, while the L2 learners have already acquired a grammar in which many constraints have been reranked, so that markedness and correspondence are interleaved in a language specific way. L2 productions which reflect this L1 ranking provide evidence of transfer. However, insofar as the initial L1 Markedness >> Correspondence ranking has not been altered during L1 acquisition, OT predicts that the highly ranked markedness constraints will assert themselves in the course of L2 acquisition. In this project, L2 Indian English speakers have provided evidence of this emergence of the unmarked, by showing the role for constraints on voiced obstruents and consonant clusters in the coda.

The use of a learning algorithm also allows us to show that speakers who begin from different L1 grammars pass through different rankings along their way to acquiring the same L2, and to test the relative importance of markedness and frequency in the OT model. Finally, it also provided another way to evaluate the relative markedness of various clusters, in this case supporting the treatment of word-final stop + /s/ clusters as at least no more marked than /s/ + stop clusters. Thus, data from Indian Englishes, and from typologically diverse world Englishes more generally, can provide insight into the form and function of markedness constraints, as well as the mechanisms of Second Language Acquisition.

Notes

1. The reductions are generally accomplished by deletion, except in the case of the lateral-nasal combination in the word *film*, which was produced by some Tibeto-Burman speakers as [flim] with metathesis instead.
2. As all correspondence constraints referred to in this chapter will compare input and output, the IO designation will be omitted in future, to save space.
3. The small degree of devoicing in both native and Indian Englishes can be attributed to an overlap in ranking in a stochastic model, as will be discussed in Section 5.

4. The preference for devoicing rather than vowel epenthesis or consonant deletion is widespread, if not universal, in response to a *VdCoda phonotactic (Steriade 2001), but is beyond the scope of this chapter.
5. With the strict ranking version of OT used thus far in this chapter, the ability of this constraint to effect additional devoicings for fricatives vs. stops and affricates is not yet clear. However, in the Stochastic model of OT discussed in Section 5, the presence of the *VdFricCoda constraint will be able to cause a greater degree of devoicing than the use of *VdObsCoda alone.
6. These last two constraints in (8) are also simplified for expository purposes and may instead be considered families of constraints whose members are strictly ranked with each other but may be interleaved amongst the correspondence constraints.
7. In the GLA model to be discussed, they would certainly lower it first because it would be violated more often: that is, any time either the SonSeq and Msd constraints were violated, and sometimes when they were both satisfied.
8. The Gujarati L1 group appears to make an equal number of errors (2 for each type); however, since there were more target stop + fricative clusters than fricative + stop clusters, they were more successful on a percentage basis on the stop + fricatives, just like the other groups were.
9. It also predicted errors which no speaker made, such as deletion of consonants and epenthesis of vowels; the use of P-Map constraint ranking (Steriade 2001) would presumably resolve those problems. The P-Map provides a basis for constraints and rankings based on the relative perceptibility of contrasts in different contexts and has been used to account for why devoicing is preferred to deletion/epenthesis in contexts where voiced obstruents are forbidden.
10. For word-final /z/, I examined the words *raise, wise, please,* and *organize.* The plural marker *s* is consistently produced as [s] by many Indian English speakers and therefore was avoided here and in the clusters in Table 29.3. However, as the production of the plural as voiceless may be attributable to spelling, three of the four words used here may also be intentionally produced with the voiceless /s/ rather than devoicing of an intended target /z/. There remains, however, a large difference between the Tibeto-Burman speakers and the Indo-Aryan (see Table 29.4), so that at least some speakers are treating these as final /z/.

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Appendix: Words used

Word-final consonants	
Voiceless stops & affricate	cheap, grip, bath, heat, caught, bet, batch, hook, back
Voiced stops & affricate	Bob, verb, hid, hide, loud, badge, bag, big, frog
Voiceless fricatives	half, this, house, race, twice, fresh
Voiced fricatives	leave, five, raise, wise, please, organize
Sonorants	zeal, from, drain, spring

Word- final clusters	
Nasal-stop	stamp, government, important, strange, turned, mind
Lateral-stop	felt, fault, held, help
Lateral-nasal	Film
Fricative-stop	hoist, insist, ask, finished
Stop-s	biceps, maths, irritates, slabs, kids, bags
Stop-stop	stopped (twice), conflict, addict
CC-s	belts, glimpse, represents, lifts, asks, interests, perfects
CC-stop	sculpt, text