Two Models for Understanding Differential Substitution in Interlanguage

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The voiced and voiceless dental fricatives /ð/ and /θ/ are among the most marked structures in the English phonemic inventory. These segments, which are not even found in the majority of the world's languages, are highly problematic for an adult learner of English as a second language. The learner, faced with a dental fricative in the L2, must select a sound that is closely related (in fact, which is minimally phonetically distinct) from the native language phonology to serve as a substitute for the difficult and unfamiliar target segment. Depending on the speaker's native language, the selection differs; this phenomenon is known as "differential substitution." For example, a speaker of Russian, Hindi, Serbo-Croatian, or Vietnamese will systematically substitute /d/ for /ð/, as in "this" and /t/ for /θ/ as in "thank you," while French, Egyptian Arabic or Japanese speakers replace /ð/ with /z/ and /θ/ with /s/. Other languages appear to use different variants depending on where the segment occurs, for instance Dutch and Korean learners use the stop substitutes /d/ and /t/ word-initially, but the sibilant /z/ and /s/ in word-medial or word-final position.

Current research on differential substitution suggests that any given interlanguage production can be explained as a result of "non-obvious transfer" from the speaker's L1 segmental inventory, and that the source of variation stems from underlying differences in native language structures. This paper will discuss two models proposed to explain differential substitution, one called the Feature Competition Model presented by Hancin-Bhatt (1994) and another, based upon a theory of Feature Pruning, in Weinberger (in press). In parts I and II, I will begin by outlining the two proposals, and Part III will address the significant ways in which their approaches differ. Part IV will suggest further implications of differential substitution for other aspects of phonological theory.

Part I: The Feature Competition Model

The Feature Competition Model, or FCM, proposes that phonological features "compete" to be noticed in the learner's input, and that those features that are most prominent or salient in the L1 inventory will be perceived and retained in the interlanguage while the less prominent features become the "variable" features that are not correctly mapped onto the target structure.

The FCM assumes that all features are not created equal, and that this inequality not only biases but eventually constrains perception of L2 input. Unlike previous analyses, the FCM claims that features do not have discrete values, but rather, are more or less prominent in the phonological inventory. Rather than be either "absent" or "present" in a matrix of radical under-specification, features are assumed to be potentially present in the "dynamic system" of the underlying representation. A feature's apparent absence is actually a lack of prominence. In fact, this distinction between the binary approach of underspecification and the "dynamic approach" of the FCM seems to be largely theoretical; as we will see, it has no real bearing on the determination of feature prominence.

In order to calculate a feature's prominence in a language's inventory, Hancin-Bhatt makes a number of theoretical assumptions based on previous research. The underlying representation (UR) of a pattern of features is minimally specified in order to achieve economy of representation. In other words, redundant or predictable specifications are simply filled in by default rules; only the distinctive features are contained in the UR. Radical underspecification takes this process one step further by completely underspecifying one segment.

The FCM's derivation of values for feature prominence draws on previous analyses of segmental transfer in which radical underspecification serves to determine feature inequality. After redundant specifications are eliminated, the most "unmarked" or predictable value of a feature is also eliminated from the UR. Markedness is determined on the basis of each language's inventory; obviously, this will result in different underspecified URs for different languages.

Having established a language's underlying representation by radical underspecification of the phonemic inventory, feature prominence can be calculated by applying a formula that compares the number of phonemic distinctions a feature makes to the total number of phonemes in the inventory. The number of phonemes a feature distinguishes is known as the feature's "functional load." The ratio of distinctions to total phonemes yields a ranking of features on a sort of "prominence continuum" --those features that make the most phonemic distinctions are ranked "most prominent" and those with the fewest number of distinctions are "least prominent." The FCM proposes that features of high prominence will be perceived and retained in a learner's interlanguage, whereas the specification of low prominence features will be variable when the learner maps the L1 inventory onto the target phonology. Thus, if a feature such as [cont] is of high prominence in the L1, we would expect the [+cont] value of the problematic dental fricative to be noticed and retained such that the substitution would match in continuance. In this case, the segmental substitute would be the sibilant /s/ or /z/.

In order to test the FCM, Hancin-Bhatt analyzes the perception of certain English phonemes by speakers of German, Japanese and Turkish. Using underspecified obstruent inventories for the three languages, the features are ranked for feature prominence according to their functional load. Predictions are made that German, Japanese and Turkish speakers will all perceive the [cont] feature of the interdentals because [cont] carries a fairly heavy functional load in the native language phonemic inventory. Perception of [cont] during feature competition will lead them to misperceive the dental fricatives as the coronal sibilants /s/ and /z/. It is predicted that Japanese and Turkish speakers will demonstrate more variable results as the prominence of [cont] is not as great as it is in the German inventory; for these two languages, [cont] is competing closely with other features.

The prediction made by the FCM, that speakers of German, Japanese and Turkish would misperceive English interdentals as coronal sibilants rather than stops, was clearly not borne out by the data. In fact, only the Germans performed as expected, although even this data is questionably significant in that the German speakers had very few misperceptions at all compared to the other ESL subjects. The

Japanese speakers seemed to misperceive the interdentals as sibilants more often than as stops, but there was considerable variation. The Turkish speakers made few of the expected misperceptions of interdentals as sibilants, but had a significant number of misperceptions of interdentals as stops, undermining the FCM's predictions. Why did the FCM fail to correctly predict the results of the test?

A primary weakness in the FCM is anticipated in a discussion of the notion of "functional load" in a footnote early in the article (Hancin-Bhatt, p. 246). The number of phonemes in a language's inventory distinguished by a certain feature determines that feature's functional load, regardless of the actual number of times the distinction occurs in the lexicon. Hancin-Bhatt concludes that while the phonemic inventory suggests a particular hierarchy of features, the hierarchy may also be affected by other variables, such as the number of lexical distinctions a feature makes in the language. A possible refinement is suggested which would add a frequency-based variable to the FCM.

In fact, this refinement, while not irrelevant, does not recognize the more serious problem with the FCM's method of ranking feature prominences based upon phonemic inventories. If features are battling for attention as the FCM supposes, with the triumphant (most prominent) feature guiding the selection of the segment used in transfer, it would be desirable to have a stronger method of determining prominence. Looking at the hypothesized prominence hierarchies for any of the languages discussed, it is hard to believe that the distinction between a feature with a 6/14 ratio and one with a 5/14 ratio is really meaningful or accurate. Because the competition is so close, the prominence hierarchies are extremely prone to disruption by other factors, including those suggested by Hancin-Bhatt: Language-specific phonetic rules, phonotactics, or lexical pattern frequencies.

Part II: Minimal Segments and Feature Pruning

An alternative solution to the question of differential substitution is offered by Weinberger (in press).

It should be stated that although these two articles share much in common -- both deal specifically with differential substitution of stops and sibilants for English interdentals in interlanguage--their goals are actually quite different. Whereas the Feature Competition Model attempted to predict the segment substituted in transfer, Weinberger's theory of Feature Pruning proposes using L2 data as a diagnostic to construct maximally underspecified matrices for the L1 phonology. In other words, Hancin-Bhatt established the feature hierarchy to predict the L2 output, while Weinberger takes the L2 output as language external evidence by which the feature hierarchy might be predicted.

Like the FCM, the model of Feature Pruning rests upon phonological underspecification theory, which claims that (radical) underspecification is valued in the grammar, accounts for rule markedness and contributes to formal simplicity or economy. Underspecification theory proposes that the UR specifies only the idiosyncratic features of a phonological system, leaving the predictable features to be derived by redundancy rules, consequently, different languages have different underlying matrices.

How can we formulate the optimal underspecified matrix for a given language? Weinberger suggests the needed evidence might be garnered by an analysis of differential substitution in L2 data . Setting the stage for the discussion of differential substitution is a presentation of a similar phenomenon that occurs with vowels in interlanguage. Vowel epenthesis--the insertion of an empty V slot as a strategy for syllable simplification--is a well known characteristic of certain interlanguages. Following underspecification of the particular L1 vowel matrix, the features of the epenthetic vowel are supplied by a redundancy rule. We can form a hypothesis about a language's optimal underspecified matrix base if we know which vowel is chosen for epenthesis in the interlanguage. In fact, such hypotheses have been confirmed by corpus-internal evidence that the underspecified "default" vowel has special characteristics and functions.

Although there are certainly similarities between an analysis of L2 vowel epenthesis and differential substitution, Weinberger notes that the two processes differ significantly because epenthesis involves the insertion of an empty V slot, whereas differential substitution works on a segment that is already there in the target language. The C slot remains, along with certain features (as we will soon see) to ensure that the problematic segment is replaced, as opposed to deleted altogether, and replaced specifically with a C segment.

Determination of an underspecified matrix for vowels using evidence from second language data suggests that a similar process might be applied to understand the variation found in the differential substitution of consonants. Again, the difficult interdental segment is addressed (this analysis uses the voiceless interdental rather than both, which behave identically differing only in issues of voicing). Russian and Japanese are examined because their inventories both contain an alveolor continuant /s/ and an unaspirated dental stop /t/. Because the articulation of these segments is very similar in both languages, explanation of the variation must be language-specific.

Assuming that the segment chosen for substitution of the interdental is the most underspecified coronal obstruent, underspecified matrices and redundancy rules can be posited for the L1. In segmental transfer, L2 learners retain many features of the problematic target segment; specifically, sonority, nasality, and value for [voice]. Other features, such as [cont], [stri] and [ant] may be variables in the selection of a minimally distinct substitute.

The fact that certain features always remain intact, while others are variable, coincides with the FCM's assertion that some features are more prominent than others in a language's phonemic inventory. We might conclude that the tenacious retention of [nas] and [voi] features in transfer from many different L1s supports a claim that these features are always highly prominent. A feature such as [cont] may or may not be prominent. In fact, it is generally accepted that features are valued differently, and in fact are organized into hierarchical structures with certain groups of features clustering together.

The tree-like structure of feature organization, after it undergoes Feature Pruning, yields a language's minimally specified representation. Weinberger adopts a feature hierarchy from Paradis and Prunet, and proposes that Feature Pruning lops off everything below the Place Node, which contains the variable feature [cont] and the cluster of features that fall under [coronal]. Information missing in the Place Node is filled in by redundancy rules formulated on the basis of the underspecified matrix. The redundancy rules for Japanese supply [+cont], and redundancy rules for Russian supply [-cont]. Consequently, since Feature Pruning implies an economy of learning, the learner need not regard any tier below the Supralaryngeal node, as these features will be automatically filled in by their L1 redundancy rules.

Part III: Comparing the FCM and Feature Pruning

The Feature Competition Model is based upon a precariously balanced hierarchy that can be toppled by any number of language-specific rules, all of which must be factored into the equation in order for the model to work. Predictions of segmental transfer require us to know:

1) the complete phonemic inventory of a language
2) the language's phonetic rules

In the "refined" FCM we would also need to know:

3) the number of distinctions each feature makes in the lexicon

This model demands that we know a language inside and out before we are able to predict which segment a speaker of this language will choose as a substitute for the L2 interdental.

Weinberger proposes a more user-friendly model, arguing that in all cases differential substitution can be attributed to one simple process: the elimination of the place node by Feature Pruning. Significantly, Weinberger does *not* propose a way to predict which features will fill the missing place node in a given interlanguage--this is the goal attempted by Hancin-Bhatt--but Weinberger's model works using the L2 data as the starting point for the construction of the L1 feature matrix. The two models cannot be compared on one level; they are not trying to accomplish the same goal. However, Weinberger's approach is economical and usable as a model for understanding a phonological process; the FCM is not. All that is required to operate the Feature Pruning Model is a minimal amount of data from L2 production. The FCM demands a tremendous amount of language-specific information to be pre-programmed into its machinery, such that it is rendered virtually unusable.

Part IV: Further Implications of Differential Substitution

One question not addressed by Weinberger's article and inadequately explained by Hancin-Bhatt is the question of systematic variation within an individual speaker's interlanguage. Hancin-Bhatt notes that Dutch speakers of ESL substitute the interdental fricative with the stop variant syllable-initially and the sibilant in syllable-final position. Her own data from the Japanese, German, and Turkish speakers suggests related evidence that stop substitutions occur far more frequently in word-initial positions than word-medially or word-finally. This is explained by the influence of 'phonological context,' and Hancin-Bhatt concludes that "The feature [continuant] is more salient in word-final position than in word-initial position, perhaps the result of suprasegmental or phonetic constraints on perception or production" (p. 262).

In fact, the systematic preference for stop substitution in word or syllable-initial position can be understood in light of Clement's theory of the Obligatory Contour Principle (OCP). Based on the idea of sonority sequencing, the OCP proposes that the syllabic onset should provide a steep rise in sonority while the coda should exhibit a minimal or gradual fall. Because the stop is the least sonorous element on the scale, a syllable-initial stop-vowel sequence is the optimal onset. The fact that ESL speakers choose a stop substitution syllable-initially and a sibilant substitution elsewhere provides support for a revision of Clement's sonority sequence that would distinguish between stop and fricative sonority values. Furthermore, this evidence would indicate language-specific differences in the strength of the OCP. In some interlanguages, the OCP guides segmental transfer to the extent that the [cont] feature is variable depending on whether it allows the optimal rise or fall of sonority. In other interlanguages, the appropriate value for [cont] is mapped onto the L2 regardless of where it occurs in the word or syllable, and it does not vary in order to conform to the OCP.

References

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