The role of L1 feature geometry in the acquisition of L2 segmental phonology: Acquiring /θ/ and /ð/ in English

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Abstract

Why do second language learners fail to acquire certain L2 phonemic contrasts even long after they have "mastered" the L2 syntax? In this paper, I seek to provide an answer to this question. Research by Brown (1993) indicates that the learner's L1 feature geometry plays a role in the acquisition of L2 segmental phonology. This hypothesis is tested by examining the inability of Japanese, German, Turkish and French (Canadian and European) learners of English to correctly perceive /θ/ and /ð/. I argue that the lack of the feature [distributed] in these languages is the source of these errors. This feature marks the contrast between /θ-ð/ and /s-z/ in English. Although feature geometry cannot predict the specific errors for each language, I argue that it can constrain the list of possible candidates which will be substituted for the interdentals. The error phones perceived share the same structure or have minimally less structure than that of the target phone. I suggest that the specific error phone is then determined at the phonetic level of the learner's L1.

1.0 Introduction

Although we as humans generally acquire our first languages (L1) with minimal difficulty, the same cannot be said for adults learning a second language (L2). Of particular difficulty is the acquisition of L2 phonology when new phonemic contrasts which are not present in the learner's L1 must be acquired. Since the ability to 'properly' produce L2 sounds hinges in part on the ability to perceive the L2 contrasts (Flege 1995; Rvachew and Jamieson 1995), this perceptual ability is of great importance. However, these perceptual and productive abilities are not easily acquired. Even after prolonged exposure to the L2, adult learners still tend to encounter difficulties in both perceiving and producing phones which are foreign to their L1 (Rvachew and Jamieson 1995; Jamieson and Morosan 1986). This fact leads to the much debated question: What is the source of this "failure" to acquire certain L2 phonemic contrasts?

In this paper I attempt to provide a possible answer to this question. Following Brown's (1993) reasoning, I shall argue that the feature geometries of both the L1 and L2 play a significant role in determining whether or not a contrast can be acquired by the L2 learner. To illustrate my argument, I will examine the inability of Japanese, German, Turkish and French learners of English to correctly perceive the segments /θ/ and /ð/, neither of which occur within the learners' L1 phonemic inventories. I will also show that feature geometry can account for (though not predict per se) the phones which are perceived in place of the English interdental fricatives by learners from each of these languages. The model of feature geometry which I use is the Rice and Avery model (cf. Brown and Matthews 1993; Avery and Rice 1989; Rice 1992, 1994).[1]

The paper commences with a brief overview of various other approaches to L2 segmental phonology followed by a summary of Brown's (1993) study which provides direction for this investigation. In §3 Rice and Avery's model of feature geometry is presented. Section 4 is comprised of the analysis of the feature geometries of English, Japanese, German, Turkish and French with reference to the phones substituted by each of the learners' languages. A discussion of this evidence will be given in §5 followed by suggestions for future research and investigation.

2.0 Approaches to L2 segmental phonology—An overview

2.1 Interlanguage theories and approaches

The interlanguage (IL) hypothesis assumes that in the course of L2 acquisition "the learner internalizes a system of rules which may be distinct from both the target language and the native language" (Eckman 1987b: 125). Three different approaches to interpreting errors resulting from the IL are outlined by Altenberg and Vago (1987). Contrastive analysis views errors as the result of interference from the learner's L1. In Error Analysis, all errors are analysed without any preconceived notions as to their source, whereas Autonomous System Analysis deals with the IL as a system unto itself and examines the characteristics of the system. But what causes these errors?

Tarone (1987) claims that learners employ negative transfer for phonemes which are absent in their L1. Thus, they simply replace the foreign segment with the closest one from their L1. This straight transfer is rejected by Beebe (1987) and Major (1987). Beebe suggests that most production errors do not result from simple substitution of phones, but are rather phonetic approximations or composites of two variants of the target sound, e.g., [sθ] or [θs] for English /s/ as produced by Chinese speakers. Major, conversely, posits the influence of both developmental factors and interference on the learner's L2 production. He proposes that interference processes predominate in early stages before they decrease in occurrence. Next developmental processes increase in use over time before they finally decrease in frequency. These stages are exemplified in the following sample from a Brazilian Portuguese speaker:

1 The Rice and Avery model which I use is a composite of the various parts of their model as they are presented and discussed in these articles.

[dɔgi] (interference) > [dɔgə] (developmental) > [dɔk] (developmental) > [dɔg]. Hecht and Mulford (1987) concur with Major as to the importance of both developmental and interference factors in L2 learning. They note both of these factors in the acquisition of English by a young Icelandic boy, Steinar. Their results indicate that transfer from L1 is the greatest predictor of segmental difficulty while developmental factors provide better insight into the actual substitutions (p.223).

Eckman (1987a[2],b) also attempts to account for the difficulty learners will encounter in the course of L2 acquisition. His Markedness Differential Hypothesis (MDH) is based on his definition of markedness which states that "a phenomenon A in some language is more marked than B if the presence of A in a language implies the presence of B; but the presence of B does *not* imply the presence of A" (1987a:60). The more marked a segment is, the more difficult it will be for the L2 learner to acquire. Thus, /θ/ would be considered to be more marked than /s/, and therefore more difficult to learn for a learner whose language lacks the segment.

2.2 Perception and feature approaches

Although accurate phonetic perception is necessary, it is not a sufficient condition for accurate L2 production (Rvachew and Jamieson 1995). Nevertheless, correlations between identification and production errors are well noted in the literature (Rvachew and Jamieson 1995; Flege 1995). Perceptual targets of L2 learners will evolve with experience but these targets will never match those of the native speakers because of interlingual identification (Flege and Hillenbrand 1987). A study by Morosan and Jamieson (1989) illustrates this point. Although they were able to train Canadian French speakers to discriminate between /θ/ and /ð/, success on this task did not carry over to an improved ability for subjects to discriminate /ð/ from /d/.

Brown (1993) also notes that the ability to detect contrasts is crucial for establishing contrasts in our phonological structure. She states that children undergo a decrease in their ability to discriminate non-native sounds with increased exposure to one specific language. At a young age, they are able to discriminate the Hindi /t/ versus /t̪/ as well as the Salish velar and uvular stops /k/ and /q/. However, since English does not contrast these places of articulation, English children eventually lose their perceptual discrimination abilities for these segments. In light of these sorts of facts, Flege (1995) claims that linguists need to do more than simply list the features of both the L1s and L2s to account for the errors made.

Listing features, however, is precisely how Hancin-Bhatt (1994) approaches her analysis. She states that a model of segment transfer must be able to explain how certain features are more apt to be maintained in transfer whereas others are more

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2 This paper is a reprint of the original article from 1977 in *Language learning* 27: 315-30.

likely to change (p.243). Using a Feature Competition Model (FCM), she attempts to account for the mapping of L2 sounds onto L1 sounds. This model assumes that not all features are of equal prominence in a given inventory and that this feature prominence is determined by underspecification. The more contrasts a feature marks in a language, the more that feature will be maintained when perceiving a non-native sound. She tests her model by verifying the perception of English /θ/ and /ð/ by Japanese, German and Turkish speakers. Since [continuant] marks a statistically significant number of contrasts in each of these languages (cf. Hancin-Bhatt 1994: 255-257), she hypothesises that this feature will be maintained when subjects perceive the interdentals. Contrary to her prediction however, Turkish listeners more commonly mistake the interdentals for stops whereas the Japanese and German subjects more commonly perceive the segments as /s-z/.

2.3 Brown's (1993) feature geometry approach to L2 segmental acquisition

In her paper, Brown (1993) reports that L1 grammar may block access to Universal Grammar (UG) during L2 acquisition thus preventing native like attainment of phonemic contrasts not present in the learners' L1. She implements feature geometry as the key tool in her investigation into the acquisition of the English /l-r/ contrast by Japanese and Mandarin speakers. These phonemes are contrasted by the feature coronal as indicated in (1):

(1) a. /l/
ROOT
SV PLACE

b. /r/
ROOT
SV PLACE
coronal

Both of these segments share the same manner of articulation, approximate, which is represented by the node Spontaneous Voicing (SV). Therefore, according to Brown, it is the feature [coronal] which distinguishes /r/ from /l/. In languages where these segments are non-contrastive, they would share the same representation. Japanese provides an example of this fact where /l/ and /r/ are allophones of the phoneme /ɾ/ represented in (2).

(2) /ɾ/
ROOT
SV PLACE

The phonetic output or allophonic variations would be determined by the phonological environment. In light of the differences in the underlying representations of these phones between English and the subjects' L1s, Mandarin and Japanese, Brown investigated whether the L2 learners could acquire this non-native contrast. Since both Japanese and Mandarin include these phones as allophones in their L1, Brown expected that neither subject group would be able to perceive the phonemic contrast. The results of her study both support and contradict her hypothesis. Japanese speakers were unable to perceive the difference between /r-l/. By contrast, the Mandarin speakers perceived the contrast well above chance levels. Since both groups of subjects were evenly matched for age of exposure, education, and time resided in North America, Brown closely examined the differences in the feature geometries of the two languages. She postulated that if a feature defining an L2 contrast was present in the learners' L1, even if it was not used in the representation of the native sound of the contrast, then they would be able to perceive the non-native contrast. By examining Mandarin, Brown discovered that the feature defining the contrast, [coronal], was present in this language. Japanese, however, does not require [coronal]. From these results, Brown concluded that the lack of a relevant feature in a learner's L1 will inhibit his or her ability to perceive L2 contrasts based on this feature. It is this last statement which serves as the main hypothesis to be tested in this paper using the English interdentals, /θ/ and /ð/, as the means for verification. This test provides the opportunity to verify Brown's hypothesis as well as to see if the L1 feature geometries tell us something about the sounds which are perceived in place of the interdentals.

3.0 Feature geometry and the Rice and Avery model

The theory of feature geometry can best be summarised by examining the common thread which weaves and connects the various models. In this section I will commence by providing a brief background to feature geometry before proceeding to a discussion of the Rice and Avery model which will be used in this analysis.

3.1 Feature geometry

The main thrust behind feature geometry is that the distinctive features which create segments are arranged in a hierarchy (Brown 1993; Brown and Matthews 1993; Clements 1993; Clements and Hume 1994; Avery and Rice 1989; Rice 1992, 1994; and Stemberger 1991). This hierarchy captures the dependency relations between features and defines the natural classes of features that function together in phonological processes. Furthermore, markedness relations are also displayed by the segmental structure. The more marked a segment is, the more structure it will possess (Rice 1992, 1994). No one language will avail itself of all aspects of feature geometry, however, it can account for all the phonemes and inventories of the world's languages.

Moreover, feature geometry captures two primary relations: dependency and constituency. Dependency results when a feature or node is dominated by a superordinate node, thus becoming the superordinate node's dependant. In Constituency, features that pattern together are organised under a common node. Constituency is created within organising nodes (e.g., Place) which are universal across languages and which are fully specified in the geometry (Stemberger 1991). By contrast, content nodes differ from language to language and are not always fully specified, e.g., [coronal]. When content nodes are not fully specified, a default feature is supplied at a later stage in order to articulate the sound.

Underspecification plays a critical role in feature geometry. It is concerned with which features are predictable and how they are then subsequently filled into the appropriate slots in the geometry. The degree of underspecification is highly variable across theories. Three main types of underspecification exist, namely Radical Underspecification (RU), Contrastive Specification (CS), and Minimally Contrastive Specification (MCS)[3] (cf. Stemberger 1991 and Dresher et al. 1994 for descriptions of each theory). These theories differ in their use of bivalent versus monovalent features. MCS is the only theory which strictly employs monovalent features although Clements and Hume (1994) indicate that the Place features labial, coronal and dorsal are monovalent within CS. The use of monovalent features rests upon the assumption that the mere presence of a feature denotes the active involvement of the articulator in segmental production (Brown and Matthews 1993).

3.2 Minimally contrastive specification and the Rice and Avery model

According to the MCS theory, unmarked content features are absent in the underlying segmental representation (UR) (Rice 1992, Avery and Rice 1989). Universal Grammar (UG) provides information as to the markedness of features and therefore determines their presence or absence in the UR. Since [coronal] is deemed to be the unmarked place of articulation, it is underspecified in the UR and later filled in by default rules at the time of articulation. In some cases [coronal] will need to be specified if a language makes a further contrast within the class of phonemes already distinguished by [coronal]. An example from Sanskrit illustrates this point. Sanskrit maintains a contrast between /t/ and /ṭ/ (cf. Avery and Rice 1989: 192). Both segments are coronal stops and therefore need further elaboration of the [coronal] node to be able to distinguish between them. The alveolar /t/ differs from the retroflex /ṭ/ by means of the [coronal] dependent feature [retroflex]. This is accomplished through the Node Activation Condition (NAC) (Avery and Rice 1989; Brown and Matthews 1993). The NAC stipulates that "if a secondary content node is the sole distinguishing feature between two segments, then the primary feature is

3 This theory is also known as Modified Contrastive Specification (Dresher et al. 1994).

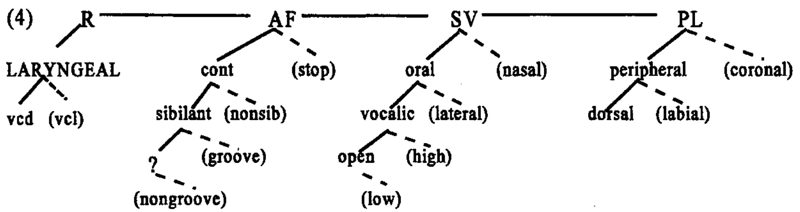
activated for the segments distinguished. Active nodes must be present in underlying representation" (Avery and Rice 1989:183). According to the NAC, [coronal] will be present for both the plain alveolar /t/ and the retroflex /ṭ/ which is then further distinguished by the secondary feature [retroflex].

A further characteristic of the Rice and Avery model is that features are not simply organised into hierarchical constituents, but these constituents are also further organised into a hierarchy rather than a flat structure (cf. (3) and (4)). As outlined in Dresher et al. (1994), the hierarchy employed by this model is indicated in (3):

(3) ROOT
| AIR FLOW
| SONORITY
| PLACE

According to this hierarchy, place contrasts are made within manner classes (Air Flow) and not vice versa. Furthermore, it more fully demonstrates fidelity to the concept of hierarchy within segmental structure. A composite of the Rice and Avery model for consonants is elaborated in (4)[4] (cf. Brown and Matthews 1993; Rice 1992, 1994; Avery and Rice 1989; Dresher et al. 1994).

(4)



R=Root AF=Air Flow SV=Sonorant Voice PL=Place

4 This composite combines the basic structure illustrated in Brown and Matthews (1994) and the hierarchy in (3) (Dresher et al. 1994). It also includes the Laryngeal node to account for voicing which is missing in the Brown and Matthews model. The Laryngeal node is attached separately from the hierarchy as it is shown to be separate in Rice (1992) and Avery and Rice (1989). Furthermore, since [voiceless] is generally considered to be the unmarked feature, it is shown in parentheses in the model. One modification that I have made to this model is to the Place node which only includes [coronal], [labial] and [dorsal] as in Avery and Rice (1989) and Rice (1992, 1994). I will be assuming dorsal dependent nodes as in Clements and Hume (1994), Clements (1993) and Yu (1992). These features are better able to account for the German fricative contrasts (cf. §4.4).

In (4), the nodes located on the right in parentheses are the unmarked and default features. These features are underspecified in the UR, but are filled in at the phonetic level if their superordinate node is activated. Furthermore, if a dependent feature is present in the UR, its superordinate node must also be present in the UR.

Each of the organising nodes establishes contrasts. In this model, Laryngeal accounts for voicing of non-sonorant consonants. When it is absent, the consonant surfaces as voiceless. The Air Flow node indicates the manner of articulation. Nasal stops also include this as a bare node indicating that the consonant is indeed a stop (cf. (5)). In order to contrast sonorants from obstruents, the Sonorant Voice node (SV) is included in the representation of the consonant where the default feature is [nasal]. The node of particular interest for this paper is the Place node. Arguments for this structure as indicated in (4) are found in Rice (1994) and Avery and Rice (1989). Peripheral denotes any consonant that is non-coronal.

In constructing the geometries, segments are specified minimally including only those features which are needed to distinguish them from other consonants in the language's inventory. Some examples of prototypical consonants are given in (5) to illustrate the model as outlined above (cf. Brown and Matthews 1993).

(5)	/t/	/p/	/k/	/n/	/m/	/ŋ/
	Root	Root	Root	Root	Root	Root
	AIR FLOW	AIR FLOW	AIR FLOW	AIR FLOW	AIR FLOW	AIR FLOW
	PLACE	PLACE	PLACE	SV	SV	SV
		peripheral	peripheral	PLACE	PLACE	PLACE
			dorsal		peripheral	peripheral
						dorsal

These sample consonantal geometries provide an excellent sample of the increase in complexity embodied in the structures.

It will be using this model as outlined above that I will argue that feature geometry does indeed provide insight into the ability for L2 learners to acquire contrasts not present in their L1. I now turn to this issue.

4.0 The role of L1 feature geometry in L2 acquisition of /θ/ and /ð/

As previously discussed in §2.3, Brown (1993) concluded that the Japanese speakers were unable to perceive the /r-l/ contrast because their language lacked the feature [coronal] which was crucial to the distinction in English. Since Mandarin does employ [coronal], albeit not for this contrast, these speakers were able to perceive the contrast well above chance levels. Following Brown's reasoning, I will argue that L2 learners will be unable to perceive the English segments /θ/ and /ð/ if their language does not employ the feature needed to distinguish these segments from other consonants in English. These learners are native speakers of Japanese, German, Turkish, and French (in particular the Canadian dialect).

After presenting the perception errors made by each of these language groups, I shall establish the feature required in English to create the contrast of /θ/ and /ð/ from other segments. I will then proceed to examine the feature geometries of each of the learners' native languages to verify the absence or presence of the feature in question. I will also investigate the structure of the L1 geometries to establish whether the feature geometries of the L1s provide any insights into the phones which were perceived in lieu of the interdentals.

4.1 Misperceived phones — the data

Data regarding the phones perceived in place of the English interdentals come from two sources. The Japanese, German, and Turkish data are found in Hancin-Bhatt (1994) and the French data come from Morosan and Jamieson (1989). The misperceived phones are shown in Table 1:

Table 1 Misperceptions of English interdentals by L2 learners

Japanese	German	Turkish	French	
			Canadian	European[5]
/s-z/	/s-z/	/t-d/	/t-d/	/s-z/

These data, particularly the data from Hancin-Bhatt (1989), reflect tendencies in the errors rather than absolute misperceptions. In her outline of errors, Hancin-Bhatt indicates that variability does occur such that on some occasions a stop may be perceived in lieu of the more common sibilant error, and vice versa. While acknowledging that this variability does arise, the main focus will be on the more common misperceptual error phones. Although interdentals were also mistaken as labiodentals (/f/ and /v/), even by native speakers in the study by Hancin-Bhatt

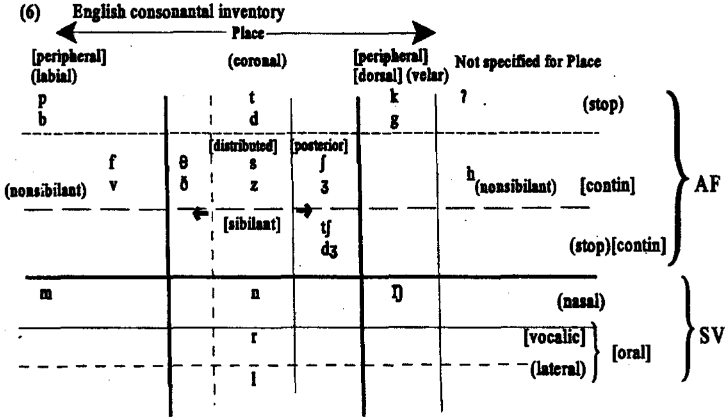
5 European French speakers are reported to produce and perceive the English interdentals more as sibilants than stops. This, however, is variable (Flege 1995; p.c. with Chris Miller and Julie Auger). Using these data which stem in part from the production of European French speakers rather than from perception is based on the concept that "transfer...is reflected in production, though,...it actually originates in perception" (Hancin-Bhatt 1994:263).

(1989), this error phone is most likely the result of acoustic similarity.[6] In light of this explanation, this error will not be discussed further.

4.2 English feature geometry—The contrast between /θ/ and /ð/

To commence the analysis, it is necessary that the distinguishing feature for the English interdentals be established. To do this, I will determine the contrastive features used within the English consonantal inventory shown in (6) based on the insights from the Rice and Avery model from §3.2. Place distinctions are also made based on the descriptions of labial, coronal and dorsal by Clements (1993).

(6) English consonantal inventory



Several points are noteworthy with regards to the inventory above. First, Avery and Rice (1989:190-1) note that the glottal stop has no specification for place. This allows for the alternation between the glottal stop and /t/ in words like [bʌʔn̩] 'button'. The unmarked node [coronal] can either be filled in to be realised phonetically as [t] or left empty for the glottal stop. The liquid /r/ has been marked here as [vocalic], however Brown (1993) notes that this segment is distinguished from /l/ by the Coronal node (cf. §2.3 (1)). Since this difference is of no consequence to the question at hand, I will not make any further claims as to the actual distinctions required. Furthermore, I have not included the glides /w/ and /j/ in the above inventory since they provide no further insights into the query of interdental acquisition. These glides could, however, easily be fit into the inventory by further elaborating the SV node. Another aspect of the inventory which should be explained

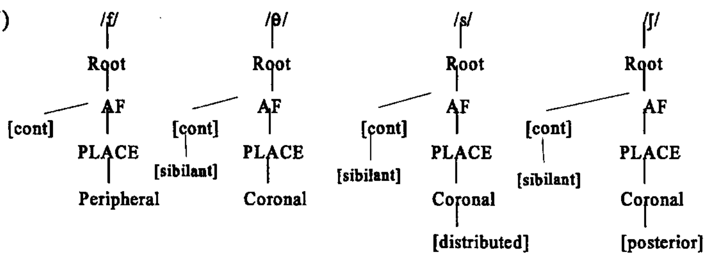
6 This substitution is well documented even in some dialects of English (cf. Murray 1995: HO 7).

is that the nasals have not been grouped under the AF node. This is only because nasals are not contrasted within AF as are continuants and stops. This does not preclude, however, the existence of the AF node for nasals indicating that nasals are indeed stops. Furthermore, segments have not been distinguished by voicing in (6).

The contrasts which are relevant for the analysis involve the Place node distinctions for the fricatives. The segments marked under [coronal] need to be distinguished from one another. First, following the distinctions outlined by Avery and Rice (1989:192) where the palatal-alveolar series of consonants were distinguished from the dental and retroflex series by the feature [posterior], I have distinguished the segments /ʃ/ and /ʒ/ from the other [coronal] fricatives by [posterior].[7] This also avoids two dependent nodes attached to [coronal] for the structures for /s/ and /z/, although this does not seem to present a problem for Clements and Hume (1994). These alveolar fricatives are distinguished from the interdental fricatives by the feature [distributed] (Stemberger 1991:102; Katamba 1989: 55). Distributed marks the difference between segments articulated with the blade as opposed to the tip of the tongue. Also, [sibilant] is present not so much as a means of establishing a contrast but rather because its absence would result in the default feature [nonsibilant] (cf. (4)).

The geometries of these fricatives are given in (7). The voiceless series will be given to maintain simplicity since their voiced counterparts differ only with regards to the addition of the Laryngeal node [voiced] (cf. (4)).

(7)



The node [coronal] is included in these representations as required by the NAC (cf. §3.2). At first glance it appears that /θ/ is less marked than /s/ according to the tenet stating that more structure means more markedness. This would seem to contradict the assumption that /s/ is less marked than /θ/ particularly in light of its early acquisition by children learning English as their first language (Sander 1972).

7 The /s/ could alternatively have been marked by [anterior]. This would not create a tremendous difference overall. However, for the purposes of uniformity, I shall maintain [posterior].

In reality, the voiced interdental occurs with a high frequency in common words including *they, this, there, their, then, them, that,* and most importantly *the* (Jamieson and Morosan 1986: 213). Furthermore, the phoneme /s/ could very well have been acquired first without the use of [distributed]. As the child detected a contrast between /s/ and /θ/, then he or she could have increased the structure necessary to distinguish these two phonemes, thus adding the necessary feature [distributed] (cf. Brown 1993; Brown and Matthews 1993). Another consideration is that there could be a difference in terms of phonetic and phonological markedness. Although /s/ is clearly less marked with reference to its frequency, it may very well be phonologically more marked (Keren Rice, p.c.).[8] Another marked feature, [sibilant] has also been included in the geometries not as a means of establishing a contrast, but rather because its absence would default to a [nonsibilant] feature (cf. (4)). Putting these issues aside for the moment, I will proceed to examine the feature geometries of the learners' native languages.

4.3 Japanese

The Japanese inventory is small in comparison with that of English. It does not contrast any segments within [coronal] as already indicated by Brown (1993). The inventory, taken from Brown (1993: 203) is given in (8) below.

(8) Japanese consonantal inventory

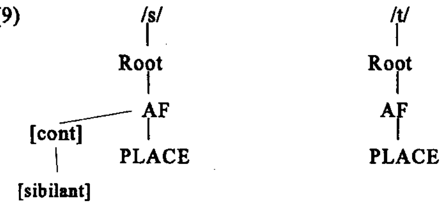
[peripheral] (labial)	Place (Coronal)	[peripheral] [dorsal]			
p b	t d	k g	ʔ (Stop) No specification for place?		AF
	s z		h [cont]		AF
m	n	ŋ	(nasal)		SV
	r			[oral]	SV
w	y			[oral]	SV

8 Keren Rice (p.c.) admits that the representations of these fricatives are difficult to deal with. She also notes that there are apparently some languages where there is language change and variation between /s/, /θ/ and /l̥/, indicating that there is something very close about these sounds when they are not contrastive with one another.

Since there are no contrasts made within [coronal], this node will be underspecified in the UR. Furthermore, since the features from SV which are required to differentiate the liquid from the glides do not pertain to this study, I have not fully distinguished these segments.

The absence of the feature [distributed] in Japanese confirms the hypothesis explaining the failure to perceive the interdentals in English. A closer look at the geometry of the fricative /s/ in (9) also reveals a similarity to /θ/.

(9)

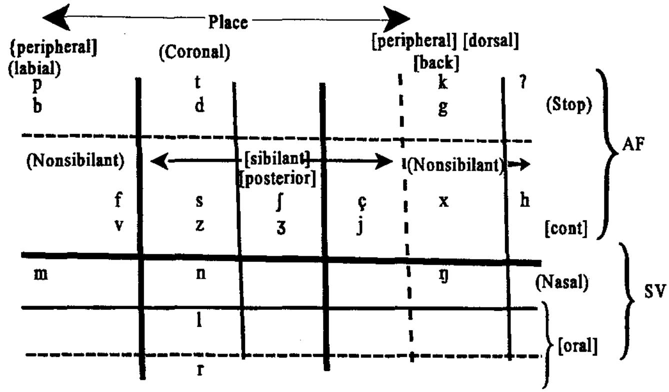


The Japanese /s/ shares a very similar structure with the English /θ/. The main difference is the [coronal] node specified within the UR for /θ/ because of NAC, otherwise, these are essentially the same representations. Taking this explanation one step further, the less common (yet still existent) misperception of /θ/ as /t/ could easily be explained by the delinking of the [continuant] node. Delinking is also a common phenomenon in feature geometry.

4.4 German

Like Japanese, German native speakers tend to misperceive the English

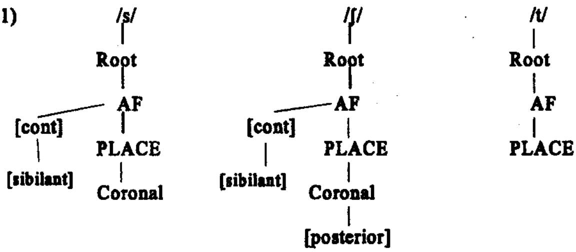
(10) German consonantal inventory



interdentals more commonly as the sibilants /s/ and /z/ (cf. §4.1). An examination of the German consonant inventory quickly reveals the lack of the feature [distributed] further providing support for the hypothesis. This inventory in (10) comes from Yu (1992). Yu alludes to the feature [distributive] in German, however, in the underspecified feature matrix, [distributive] is not present since it is noncontrastive in German, and therefore unnecessary as a feature in the geometry (Yu 1992: 146). One notable difference observable in the German inventory is the three-way contrast between dorsal fricatives. The palatal fricatives are easily distinguished from the other two dorsal series by [sibilant]. The velar fricative /x/ is subsequently distinguished from /h/[9] by the dorsal dependent [back] (Yu 1992; Clements 1993; Clements and Hume 1994; Katamba 1989).

The resulting feature geometries for /s/, /ʃ/, and /t/ are illustrated below in (11). Although German speakers generally tend to misperceive the interdentals as the sibilants /s/ and /z/, they do occasionally claim to hear /t/ and /d/ (Hancin-Bhatt 1994). The alveopalatal fricative is also illustrated in (11) to see if it provides any

(11)



insights into the "choice" of perceptual error phones. Similar to the Japanese data, the structure for German /s/ matches that of /θ/ in English. This is significant since this model of feature geometry is based on contrasts between segments and both the English /θ/ and German /s/ are defined by the same contrasts. Another similarity is found with the German /t/. Since /t/ would be realised as [coronal], the interdental differs minimally from /t/ only with respect to [continuant] (the overt specification for [coronal] in the UR not being considered a difference). The loss of [continuant] by delinking would produce a similar structure as /t/. By contrast, /ʃ/ is not misperceived in lieu of /θ/. The structures of these two segments also differ

9 Once again the existence of /h/ presents a problem for Place. I have grouped it here under dorsal, however, it may very well not belong in this position. If this is indeed the case, then the feature [back] would be redundant since [sibilant] would already create the contrast between the palatal and velar fricatives. Nevertheless, this issue does not bear significant weight on the results since the existence of this feature is not in question in this study.

minimally with respect to one another. The significant difference, however, is that /ʃ/ is a more marked and more complex segment with the addition of the feature [posterior].

4.5 Turkish

One of the difficulties with analysing the Turkish inventories is the vast proliferation of inventories, none of which concur (cf. Hancin-Bhatt 1994; Van der Hulst and Van de Weijer 1991; Demircan 1987; Underhill 1986; and Lees 1961). Thus, the reliability of the data provided is not guaranteed. For the sake of simplicity, I shall use the obstruent inventory from Hancin-Bhatt (1994) with some of the insights from Underhill (1986). Although this ignores the sonorants, even a cursory glance at the various inventories indicates that no significant contrasts are established within the sonorant class. The inventory is given in (12).

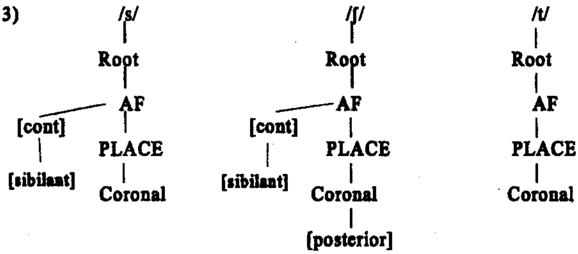
(12) Turkish Obstruent Inventory

[peripheral] (labial)	(coronal)	[posterior]	[peripheral] [dorsal]	
p	t	tʃ (ç)	k	
b	d	dʒ (c)	q* [low] g	(stop)
f	s	ʃ (ş)		[contin]
v	z	ʒ (j)	ɣ*	
(nonsibilant)	← [sibilant] →		(nonsibilant)	

*These phones are seen as allophones of their respective phonemes according to some inventories (Swift 1963)

Once again, the lack of the feature [distributed] supports the hypothesis that speakers whose L1 lacks the feature required to make a contrast in the L2 will be unable to perceive the contrast. A further look at the feature geometries of the error phones for Turkish speakers also reveals similarities to those for German.

(13)



The main difference between the German and Turkish geometries is the overt specification of [coronal] for the stop. Otherwise, the same structure for English /Θ/ represents Turkish /s/. However, in spite of the same structure being shared by Turkish /s/ and English /Θ/ as was the case with German and nearly the case with Japanese, Turkish speakers do not generally tend to perceive the English interdentals as the alveolar sibilants, /s/ and /z/ as do German and Japanese speakers. They do, instead perceive the stops /t/ and /d/ with greater frequency (cf. Table 1). With the overt specification of [coronal] for the Turkish /t/, the two phonemes become even more similar, distinguished only by [continuant] (cf. §4.4 for further details as to the similarities). Once again we see that the two possible error candidates possess either the same structure or minimally different structure, where minimally different implies minimally less structure.

4.6 French—[t] versus [s]

In sections 4.3 to 4.5, three different languages have been highlighted. All of these languages have been proven to not use the feature [distributed] in establishing contrasts. However, despite shared feature geometries of the misperception errors of the various languages, two different error phones abound. In this section I will outline the inventory for French which exemplifies this very phenomenon of different error perceptions coming from similar or like inventories and feature geometries.

Before investigating the feature geometry to verify if it provides illumination as to a possible predictor of the phones misperceived, I will outline the consonantal inventory of French to determine whether [distributed] is a contrastive and thus necessary feature in its geometry.

4.6.1 The consonantal inventory

The inventory for both European French (Standard French) and Canadian French are the same (cf. Rogers 1991, Léon 1966) with perhaps the variation of the "r" regionally (Rogers 1991: 111-112). Nevertheless, the contrasts within the inventory are easily made as shown below in (14):

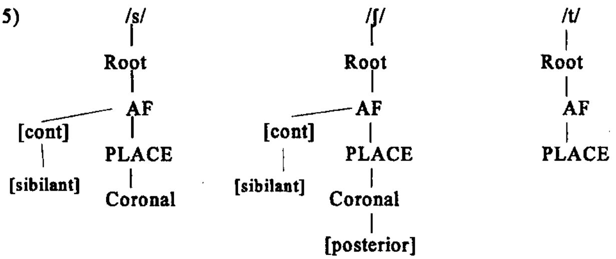
(14) French consonantal inventory

[peripheral] (labial)	(coronal)				[peripheral] [dorsal]		
p b	t d				k g	(stop)	AF
(nonsibilant) f v		s* z*	(sibilant) ↔	[posterior] ʃ ʒ		[contin]	AF
m	n			ɲ	ŋ†	(nasal)	SV
	l					[oral]	SV
	r						SV

* The /s/ and /z/ are shown to be distinct from /t/ and /d/ which are considered to be more dental. Some sources group them together under "alveolar" whereas others distinguish the /s/ and /z/ as predorsal-palatals (FREN 433 Handout).
† This nasal is used only in borrowed words (Rogers 1991).

Once again the feature [distributed] is absent from the inventory further providing support for the hypothesis. Moreover, the feature geometries for /s/, /ʃ/ and /t/ also reveal similarities to those structures already given above for the other languages.

(15)



These structures in fact are the same as those required by German (cf. §4.4 (11)). The structure for /s/ also perfectly matches the structure defining /θ/ in English. This likeness of the two structures, French /s/ and English /θ/, could easily account for the misperception of /θ/ as /s/ in European French. The further explanation for the error /t/ could once again be expressed as the delinking of the [continuant] feature, thus rendering a structure similar to that of /t/ with only the overt specification required by /θ/ distinguishing them. As also earlier suggested, the additional structure of the

French /ʃ/, though producing a minimal difference, could account for the lack of /ʃ/ to be experienced as an error phone.

5.0 Discussion of results

5.1 Support for Brown's hypothesis

Brown's (1993) hypothesis appears to be confirmed by the data and results above. The distinguishing feature creating the contrast between the interdentals and the other fricatives, especially /s/ and /z/ is [distributed]. The fact that this feature was not actually attached to the interdental fricatives per se is not a problem. The important fact remains that it is this feature which is required to establish the contrast. Without this contrast, /θ/ and /s/ would "neutralise" in English. Not only did the L1s of the speakers lack this feature, but these speakers made errors in their perception of /θ/ and /ð/. Thus, these results support the claim that if a learner's L1 does not employ a feature required to create a contrast in the L2, this speaker will be unable to perceive the L2 contrast marked by the feature with native-like competence. From this claim it can further be stated that feature geometry does in fact play a real role in the ability for L2 learners to acquire foreign contrasts.

This claim could also be used to explain the results of the popular problems with French learners of English as demonstrated by the results in Morosan and Jamieson (1989). As discussed earlier, the authors were able to train Canadian French speakers to detect voicing differences between /θ/ and /ð/ with a high degree of accuracy in word initial position. This was an accomplishment since not only do interdentals not exist in French, but English and French also differ from each other with regards to VOT (Flege 1995; Flege and Hillenbrand 1987; Jamieson and Morosan 1986, 1989; and Morosan and Jamieson 1989). Despite the success at distinguishing between interdentals, this success did not carry over into the subjects' ability to discriminate between /ð/ and /d/. This further supports the hypothesis since not even training subjects in discrimination can force a "renovation" of the feature geometry structure of a language. It is important to note that these subjects were monolingual francophones attending a summer school in Kingston to learn English. Similar problems in discrimination are not necessarily experienced by bilinguals for whom French is the first language (Alain Theriault, p.c.).

In yet another application to the French problem, both the lack of [distributed] as a contrastive feature in French as well as the effect of L1 feature geometry on L2 acquisition could be the motivating factor behind the French constraint against interdentals as described by Paradis and Lebel (1994). The authors explain the constraint as the reason "why interdentals are systematically adapted as soon as words containing them are introduced into French" (Paradis and Lebel 1994: 75). The lack of [distributed] could very well explain the "why" behind the contrast.

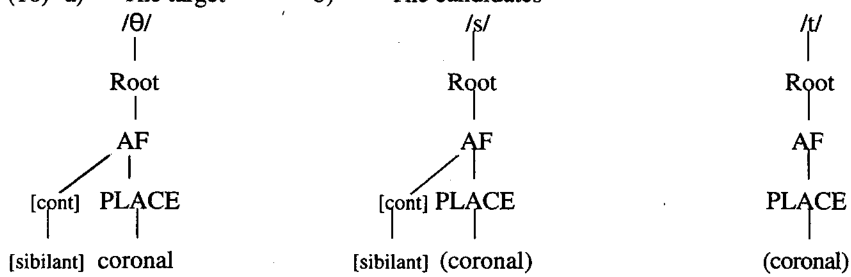
5.2 Predictability of errors from feature geometry?

Verifying Brown's hypothesis was far more straight forward (despite its length) than an account of predictability. In light of the identical feature geometries of both German and French and yet the differing errors, it is difficult to propose that feature geometry has predictive power as to the error phones. The fact that French yields two different misperceived error phones from the same inventory and geometries provides unequivocal proof against predictability. However, does this simply mean that any L1 segment can be considered a candidate for being an error phone misperceived in place of the target phone? The answer is a resounding no!

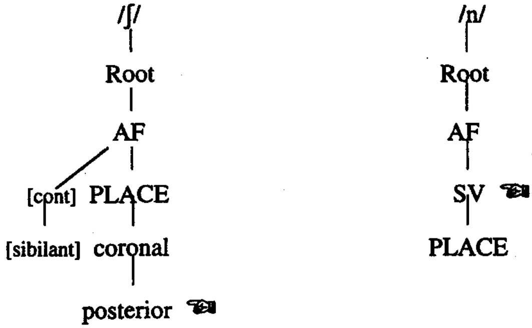
The error phones clearly indicate a select choice of "possible" misperceptions. Not every consonant from the languages' inventories were error substitutions. Recall from Table 1 (cf. §4.1) that the phones perceived were either /s/ and /z/ or /t/ and /d/ where voicing was deemed irrelevant. The alternative error phones, the labiodental fricatives /f/ and /v/ were explained based on an auditorily based substitution. However, even within languages the error phones recorded in the table reflect only tendencies and not absolutes permitting essentially, to a certain extent, both the stops and sibilants to be candidates even within a specific language. Hence, what I propose is that although the feature geometry cannot predict which phones will be heard in lieu of the target sound, it can constrain the candidates from the numbers of possibilities in the L1. But how does this constraining operate?

As suggested earlier, the error phones either share the same structure (e.g., /s/) or have minimally less structure than that of the target phone (e.g., /t/). The differences between specification or underspecification of [coronal] in the URs do not appear to play a role or affect the outcome of the comparison of structures since in both cases the feature is actually an inherent part of the make up of the phone. Segments, however, which differ minimally more such as /ʃ/ are not candidates for misperception. To illustrate this generalisation, several feature geometries of both attested errors and unattested error substitutions have been reproduced in (16).

(16) a) The target b) The candidates

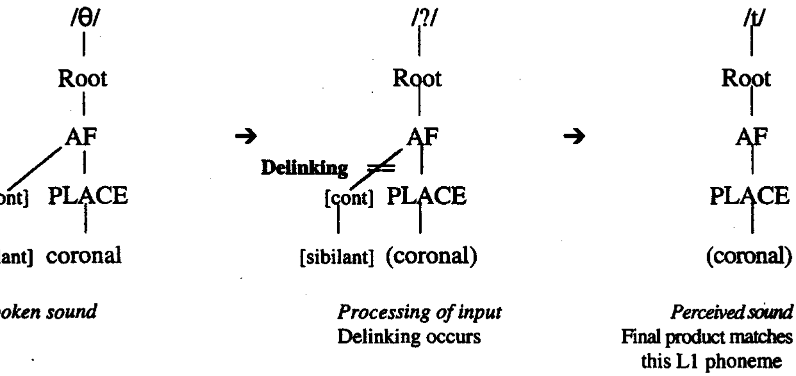


c) The Non-candidates



Although only a few examples are given, those that are illustrated represent phonemes found within all inventories outlined in this analysis with the exception of /ʃ/ which is not found in Japanese phonemically. The candidates shown in (16.b) demonstrate my proposal. The structure for /s/ is identical to that for /θ/ in (16.a) (where coronal is shown in parentheses to indicate that it may either be specified or underspecified due to the NAC). The representation for /t/ differs only by the absence of the [continuant] node. This is easily accounted for by the process of delinking the [continuant] node to which perhaps some learners do not attend thereby producing or perceiving the stop through default. This delinking is illustrated in (17):

(17)



The representations of the Non-candidates in (16.c) share one thing in common. These representations have added structure to the original geometry of /θ/. For /ʃ/, the addition of [posterior] marks the only difference between the two segments.[10] As for the nasal, /n/, the [continuant] node has been delinked as was the case with /t/, however, the SV node which has [nasal] as its default has been added. Clearly this is not a simple case of minimally less structure. The features which violated the minimally less option are indicated by the pointed fingers to the right of each structure in (16.c).

Thus, there appears to be a means of predicting or constraining the possible candidates which will be perceived (or produced possibly) in place of the target phone. These predictions and constraints appear to follow the principles of Minimality and Preservation as outlined in Paradis and Lebel (1994). They define a Repair Strategy as "a universal context-free phonological operation that inserts or deletes structure to make a phonological unit or structure conform to a constraint" (p.77). Although my proposal necessitates only the deletion of structure, the principle of Minimality can account for this deletion in that it "must involve as few strategies (steps) as possible" (p.77). In this case the candidates represent the deletion of only one node (even though it may include its dependent nodes as well). Most notably is the principle of Preservation which requires that segmental information be maximally preserved and maintained (p.78). These principles contribute to the constraining of perception error candidates.

5.3 Accounting for the choice of which error candidate

Having arrived at the list of possible candidates, how is the specific error determined? This topic had been debated, particularly for French, since the different dialects tend to show varying inclinations towards a particular error substitution.

Tom Wilson (MS) tried to account for the differences in French substitution errors by employing a lexical phonology approach. He claimed that the default and redundancy rules filled the appropriate feature value as shown in an example in (18):

(18) [+continuant] → [+strident]

He then proposed that the feature value was filled in lexically for Canadian French (CF) but postlexically for European French (EF). If this was indeed the case, and assuming that only postlexical rules can be transferred from L1 to L2, then this supposedly would account for the sibilants in EF and the stops in QF. This, however, does not take into consideration variation within dialects and idiolects.

Another consideration that has been raised is word position. Differences in errors can be contrasted based on word position (Hancin-Bhatt 1994; Flege 1995).

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10 If my proposal does bear any truth, this could also prove a further impetus to the use of [posterior] for /ʃ/ rather than marking /s/ for [anterior] to create the contrast.

Hancin-Bhatt (1994) noticed differences in the rates and types of errors based on word position. Flege (1995: 264) noted that Dutch learners of English use /d/ for /ð/ word initially but then use an alveolar fricative word finally. Thus, word position may be a consideration in the choice of error phones.

Another possible insight into whether the stop or fricative series will be "chosen" as the error phone may be tongue position in the production of /s/. Allison Teasdale (p.c.) has recently finished a phonetics study to explain the substitution errors for the English interdentals by learners of English. She found that speakers who produce /s/ further forward, i.e. a more dental /s/, substitute /s/ for /θ/. On the other hand, speakers who produce an alveolar /s/ are more apt to substitute /t/. This claim is supported by two different pieces of evidence. First, Flege and Hillenbrand (1987) claim that French and English /s/ are not both produced as alveolars. Only the English variety is an alveolar whereas the French /s/ is more of a dental. This sweeping generalisation of French, however, could be disputed by the findings of Teasdale. Another piece of support comes from Rice (1994: 201) who states that "a single phoneme can take on a range of phonetic realizations. ...[In] languages...where there is only a single type of coronal stop, that stop may be realized as alveolar in some languages and as dental in others." There is no reason why this cannot be applied to the phoneme /s/.

Since the feature geometry does not specify the actual phonetic realisation, it is possible that it is at this level that the actual choice of an error substitution takes place. If the findings of Teasdale's study are found to be valid, then that could also account for the differences in perceptual errors. I find this former study to be promising and perhaps insightful.

6.0 Conclusions

In this paper I have provided further evidence for Brown's (1993) hypothesis as to the role of L1 feature geometry in L2 acquisition. If a learner's L1 lacks a feature important in marking a contrast in the L2, then this learner will encounter difficulties in perceiving (and perhaps producing) the L2 contrast. Furthermore, I have demonstrated that although feature geometry does not enable a prediction of the specific error phones in perception, it does constrain the possible perceptual substitution candidates using the principles of Minimality and Preservation. It is possible that the specific choice of phones perceived in lieu of the target phone could be determined by phonetic considerations as found by Teasdale in her recent study.

Therefore, specifically relating to the perception of the English interdentals, the determination of perception may be as follows. The learner's L1 feature geometry may determine whether or not he or she will be able to perceive the interdentals. Namely, if the learner's L1 contains and employs the feature [distributed], then the learner will be able to perceive the contrast; if, however, the learner's L1 does not utilise this feature, then the learner will experience difficulties in perception of English interdentals. If difficulties with interdental perception are expected, then the candidates for perceptual substitution will be determined using the principles of Minimality (where minimally different implies minimally less structure) and Preservation. Once these candidates are established, then the specific perceptual substitute will be determined by phonetic and acoustic factors such as tongue placement in the production of /s/.

Further investigation is required to verify the validity of these claims. A wider range of languages needs to be examined to determine if the existence of [distributed] is the key issue in determining ability of interdental perception. Moreover, the ability to constrain substitution candidates also needs to be tested on more languages. Most importantly, however, is the need to corroborate the hypotheses tested in this paper by studying other contrasts and phonemes being acquired by L2 learners of a variety of languages.

It seems at this stage that there is indeed validity to the claim that the feature geometry of a learner's L1 does play an important role in the acquisition of L2 segmental phonology. Further study into this area of phonology could indeed provide better insights into developing a more comprehensive model of feature geometry that is not simply able to account for phonological processes but also one that is able to account for both first and second language acquisition. There seems little doubt that there is promising work waiting to be done in this area.

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