SONORITY AND CONSTRAINT INTERACTION: THE ACQUISITION OF COMPLEX ONSETS BY SPANISH LEARNERS OF ENGLISH

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Abstract

Traditionally, considerable attention has been paid to the acquisition of L2 syllable structure. Research has focused on two main topics within this area: on the one hand, the source of errors (universal or based on L1 phonology?); on the other hand, the factors determining the choice of one strategy or another to 'repair' illicit syllable structure. In our research study we discuss the key concept of sonority in the light of the data obtained from 5 Spanish learners of English. We elicited different complex onsets from them and arrived at the following conclusions. Firstly, -s + stop- sequences were more difficult than –s + liquid- ones in spite of the fact that neither of them is allowed by the Spanish phonological system. We interpret this fact in OT terms, discussing the nature of two different sonority constraints (SONORITY and O SON) and justifying the linguistic behaviour of our learners with reference to OT learnability theory. Secondly, we contradict Hancin-Bhatt & Bhatt's (1997) claims that –stop + glide- sequences are a problem for Spanish learners of English. We suggest that the controversy regarding –consonant + glide- onsets and their implications for different sonority models (Broselow & Finer 1991, Eckman & Iverson 1993) cannot yield useful results because of the unsteady syllabic status of glides. Finally, we discuss possible alternatives to the traditional concept of sonority and their implications for L2 phonology research.

KEYWORDS: L2 syllable acquisition, Optimality Theory, onsets, language-specific sonority distance, universal sonority sequencing, dispersion, glides, phonotactics based on acoustics and perception.

Resumen

Tradicionalmente se ha prestado abundante atención a la adquisición de la estructura silábica de segundas lenguas. Las investigaciones se han centrado en dos temas principales dentro de esta área: por un lado, la fuente de los errores (¿universal o causada por la fonología de la L1?); por otro lado, los factores que determinan la elección de una estrategia u otra para 'reparar' estructuras silábicas ilícitas. En nuestra investigación discutimos el concepto clave de 'sonoridad' a la luz de los datos obtenidos de 5 aprendices de inglés hispanohablantes. Extraemos diferentes cabezas silábicas complejas, llegando a dos conclusiones principales. En primer lugar, que las secuencias de –s + oclusiva- les resultaban más difíciles que las de –s + líquida- a pesar de que ninguna de ellas está permitida por la fonología del español. Interpretamos este hecho en términos de Teoría de la Optimidad, discutiendo la naturaleza de dos diferentes restricciones de sonoridad (SONORITY y O SON) y justificando el comportamiento lingüístico de nuestros aprendices en su relación con la explicación del aprendizaje en Teoría de la Optimidad. En segundo lugar, contradecimos las afirmaciones de Hancin-Bhatt & Bhatt (1997) en el sentido de que las secuencias de – oclusiva + semivocal- son un problema para los aprendices de inglés hispanohablantes. Sugerimos que la polémica referente a las cabezas silábicas de – consonante + semivocal- y sus implicaciones para distintos modelos de sonoridad (Broselow & Finer 1991; Eckman & Iverson 1993) no puede arrojar resultados útiles a causa de la inestabilidad en el comportamiento silábico de las semivocales. Finalmente se discuten posibles alternativas al concepto tradicional de sonoridad y sus implicaciones para la investigación de la fonología de la L2.

PALABRAS CLAVE: Adquisición silábica de la L2, Teoría de la Optimidad, cabezas silábicas, distancia de sonoridad específica, secuenciación por sonoridad universal, dispersión, semivocales, fonotaxis basada en acústica y percepción.

1 An Overview of L2 Syllable Acquisition

Interlanguage syllabic structure has attracted a great deal of attention. Not only does it show a variety of phenomena related to both L1 and universal factors, but also it is accessible without much experimental complexity. The history of research in this particular field of L2 phonology also reflects more general theoretical trends in phonology over the last decades. Developments such as Principles & Parameters, Optimality Theory or the interest in prosodic studies appear in general phonological discussion and afterwards they are applied to L2 phonology research. Unfortunately, this influence is overwhelmingly unidirectional, i.e. only general phonological theory influences L2 studies, but not the other way round. This is true in spite of the fact that L2 learning data can be illuminating when considering the validity of different approaches to phonology. As far as syllable acquisition is concerned, we shall distinguish two main areas of study: on the one hand, researchers have struggled to explain the origins of phonological error, with or without explicit reference to general phonological frameworks; on the other hand, there have been efforts to explain why certain target language syllable structures were altered in a particular way.

1.1 What is to blame for errors?

The publication of Lado's *Linguistics across cultures* (1957) is the landmark for L1-based accounts of phonological error. Constrastive Analysis suggested that L2 difficulty stemmed from the difference between the learner's L1 and the target language. Thus, the statement "difference equals difficulty" was assumed in much second language research from that moment on, with the hope that contrastive studies could help students and teachers to improve L2 learning and teaching practice:

> If one could juxtapose the structures of the mother tongue against those of the target language, course designers (and teachers and learners) would be better able to plan their learning and teaching; better able to foresee difficulty and consequently better able to husband resources and direct learning and teaching effort. (James 1980: iii)

Quite soon, Contrastive Analysis proved to be a poor explanation for L2 acquisition problems in fields such as morphology or syntax. Firstly because difference between L1 and L2 does not always imply difficulty. Secondly because it was shown that most errors could be explained as the result of developmental processes similar to those found in L1 acquisition (Dulay & Burt 1974). In spite of this, L1 influence is still a matter of discussion in phonology, which seems to be an exceptional area. Ioup (1984) compared interlanguage phonological and morphological processes and concluded that transfer seems to exert a stronger influence on phonology, although there is no clear answer to the question of why this should be the case.[1]

Moving back to the specific topic of our study, it has been suggested that L2 syllabic structure is quite susceptible to L1 influence, to the extent of being regarded as the major influence in errors (Broselow 1984, 1987; Sato 1987; Tarone 1978, 1980).

Some researchers have attempted to reach a compromise between L1-dependent processes and universal forces shaping the syllables of the learner's interlanguage. Perhaps the most remarkable attempt in this respect was Eckman's Markedness Differential Hypothesis (1977). The main tenet of Eckman's theory is that difference between L1 and L2 will only imply difficulty if the element to be acquired is more *marked* than that found in the learner's L1. Eckman's approach to markedness is based on typological evidence in the form of implicational universals: if a feature X is present in a language, then Y must also be present but not inversely (Eckman 1984). For example, it is well attested that if a language allows three member onsets, two member and one member onsets will also be allowed. Consequently, three member onsets are more marked than two member ones.

Eckman's theory has been extremely influential and it is the source of much research in syllable structure acquisition carried out from the late 1970s onwards, being overwhelmingly supported by empirical studies (Anderson 1987; Benson 1986; Carlisle 1988; Eckman 1987; Weinberger 1987). More recently, some criticisms have been posed, which in turn have led to further developments to Eckman's approach (Hammarberg 1988; Cichoki et al. 1999; Major & Kim 1999).

Major (1987) introduces a longitudinal dimension in the relationship between L1 and universal factors with his Ontogeny Model. His main assumption is that "interference processes will decrease over time, while developmental processes will first increase and then decrease" (Major 1987: 104). At the beginning, the learner brings into his L2 the configuration of her mother tongue. As her awareness of being coping with a different linguistic system grows, transfer errors decrease and natural processes of language acquisition increase. Eventually, both developmental and transfer phenomena should disappear.

This general trend of considering that both L1 and universal factors should be granted a place in the explanation of L2 syllable acquisition error has been justified by resort to two main phonological frameworks: Principles and Parameters and Optimality Theory.

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[1] We may suggest that perhaps the *physical implications* of speech (both articulatory and perceptual) make L1 influence more noticeable, i.e. not only do we have to get rid of mental habits (such as placing the adjective after / before the noun) but also of habits with deep physical and psychological roots: places of articulation, rhythm, aspiration, speech perception's mental settings and prototypes, among others.

Broselow & Finer (1991) analysed the modifications made to English syllable structure by 24 native speakers of Korean and 8 native speakers of Japanese. They suggested that markedness plays a role in deciding on the difficulty of the acquisition of certain clusters, but this role is directly related to the parameter setting of the learner's L1. Consequently, the learner does not suppress all marked elements, but rather departs from the levels of markedness of his L1 and gets closer to the configuration of the target language:

> [...] at a certain stage of acquisition learners seem to arrive at a parameter setting that is midway between the native and the target language settings. This effect occurs both when the target language employs a less marked setting than the native language and when the target language setting is more marked than that of the native language. (Broselow & Finer 1991: 35)

Broselow & Finer reach the interesting conclusion that children acquiring L1 and L2 learners have access to the same Universal Grammar elements; the difference lies in the starting point: whereas L1 learners start from a least-marked parameter setting, L2 learners transfer the setting from their mother tongue.

Optimality Theory has also provided an answer to the combination of universal and language-specific factors (Broselow, Chen & Wang 1998; Hancin-Bhatt & Bhatt 1997; Hancin-Bhatt 2000). L1 is granted a place in the form of the learner's initial constraint ranking; universal factors are expressed by means of markedness constraints. Hancin-Bhatt & Bhatt (1997) point out that OT's approach is remarkably similar to Major's Ontogeny Model in its results: the high number of interference errors at the beginning is caused by the original constraint hierarchy of the learner's L1; the eventual decrease of these and their replacement for developmental ones can be explained in terms of OT learnability theory. Constraint demotion forces the learner's grammar to depart from that of his L1. Subsequently, the minimal demotion of markedness constraints displays a whole range of developmental phenomena, which are similar to the ones found in L1 acquisition. It could not have been otherwise if we assume a universal set of constraints. Broselow, Chen & Wang (1998) explain some well-known simplification patterns in interlanguage syllable structure as cases of the emergence of the unmarked: alterations in the initial constraint ranking justify that the effects of some lower-ranked constraints become noticeable in the learner's output.

1.2 What determines error type?

A question which has attracted less attention in L2 research is what type of errors learners make and what factors influence the selection of a 'repair' strategy, i.e. which means are deployed to avoid violations of phonological constraints in the learner's interlanguage. There are three main solutions to syllable structure problems: epenthesis, devoicing and deletion. The factors which favour the selection of a particular strategy have been thoroughly discussed by Carlisle (1994) and we shall only provide a brief summary:

Environment: [z] more often kept before vowel, word-final epenthesis more likely to happen before pause or consonant, rarely before vowel (Dickerson 1975); word-initial epenthesis more likely after consonants (Carlisle 1994); context also determines word-final obstruent devoicing (Edge 1991; Yavas 1994).

Markedness and sonority: Deletion cannot result in increased markedness of the sequence (Eckman 1987); perceptually salient segments are not deleted in complex onsets and codas (Tropf 1987).

Age: Riney (1990) suggests that the older the learner, the more epenthesis is likely to happen. However, findings are contradictory (see Carlisle 1994: 231).

Prosodic word size: Broselow, Chen & Wang (1998) suggest that the choice between deletion and epenthesis may be the result of metrical structure optimisation: monosyllabic words undergo epenthesis; bisyllabic words undergo deletion.

Morphology: Inflectional morphemes are usually dropped by learners and even by native speakers.

Onset vs coda: Epenthesis is preferred in word-initial onset position, whereas deletion is the main strategy in word-final codas (Hancin-Bhatt & Bhatt 1997).

2 Sonority: Universal or Language Specific?

The overwhelming majority of constraints in OT are *universal* and *violable*, i.e. all languages share the same constraints and surface differences are due to different rankings. However, Prince & Smolensky (1993) make a slight modification to this general concept when they put forward the idea of encapsulated hierarchies to deal with language-specific limitations to possible onsets, nucleai and codas. We must make clear that they only meant a simplification of the full set of conventional associational constraints, although in practical terms they were suggesting that languages establish some kind of sonority threshold for the association of certain segments to syllabic positions of the type B_{ONS}= /…/. Colina (1995) takes this discussion even further in the description of Spanish syllable structure. She proposes an onset constraint O SON which can adopt different values depending on each specific language.

> For two segments to be parsed in the same onset, a certain distance in the sonority scale must be maintained. This will vary across languages. In Spanish, Catalan and Galician, it is the maximum distance, the least sonorous onset and the most sonorous, an obstruent and a liquid. (Colina 1995)

The next question we should pose is the need of proposing a separate SONORITY constraint to rule out combinations which violate the so-called Sonority Sequencing Generalisation (Selkirk 1984). It could be argued that O SON can do the job because it specifies the order of elements (least sonorous followed by most sonorous); it is not just a statement about distance irrespective of directionality. However, the SSG comprises the sonority profile of the whole syllable, not just the onset. Furthermore, it affects all types of onset-nucleus combinations, either simple or complex. Finally, it is assumed to be a property of all languages, with a few exceptional patterns. For all these reasons we assume that the language-specific constraint cannot subsume the universal principle whereby segments are arranged in order of decreasing sonority from the nucleus to the margins. Thus we are forced to propose a separate universal constraint, SONORITY.

From the viewpoint of second language acquisition we may wonder whether there will be some difference between learning an onset which violates O SON (i.e. the language-specific constraint referring to distance) and one which violates SONORITY (i.e. the universal constraint referring to profile). This is a relevant question in the acquisition of English onsets by Spanish speakers. Spanish does not allow [sl] or [sp] as possible complex onsets. [sl] violates the minimal sonority distance between two segments in an onset, but it does not create an ill-formed sonority profile; on the other hand, [sp] incurs a more general, universal violation because it presents an irregular sonority configuration. It will be interesting to see whether one of these sequences represents a more important problem for Spanish learners of English. If this is the case, it will have theoretical implications for the status of O SON and SONORITY as separate constraints. It will also be possible to explain these differences in terms of OT learnability theory.

3 Sonority: Sequencing or Dispersion?

There has been considerable controversy about which model of sonority should be adopted in the field of L2 syllable studies. We shall look in turn at the two main approaches: the Sonority Sequencing Generalisation (Selkirk 1984; used by Broselow & Finer) and the Sonority Dispersion Principle (Clements 1990; used by Eckman & Iverson 1993 and Hancin-Bhatt & Bhatt 1997).

3.1 The Sonority Sequencing Generalisation and its application in L2 studies

Selkirk (1984) puts forward her Sonority Sequencing Generalisation (SSG) whereby "in any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values" (Selkirk 1984: 116). Each language establishes a minimum sonority dissimilarity between two adjacent elements. Broselow & Finer (1991) carried out a study where they related difficulty in complex onset acquisition and marked sonority configuration, understanding sonority in the way suggested by Selkirk. Their Korean and Japanese informants found acquiring the sequence –py- easier than all the rest and Broselow & Finer interpret that this is explained by the fact that both segments are separated by the biggest possible sonority difference. The rest of complex onsets are also presented in order of increasing difficulty, which is in turn related to decreasing sonority distance: -pr-, -by-, -br-, -fy-, -fr-.

3.2 The Sonority Dispersion Principle and its application in L2 studies

Clements (1990) suggests a different view on sonority. The most relevant difference from the perspective of L2 studies is his model of optimal sonority profile. For Clements the preferred combination is a sharp, steady increase of sonority in the onset and a minimal decrease in the coda (with the optimal CV sequence having no decrease at all).[2] This represents a problem for Broselow & Finer's (1991) claims that –py- is the least marked of English onsets: it presents a sharp increase from –p- to –y-, but then it practically levels out from –y- to the nucleus.

Eckman & Iverson (1993) published a devastating critique of Broselow & Finer's work. They argue that –py- in Korean should not be analysed as a complex onset, but rather as a simple onset followed by a diphthong. Their support of Clements' approach to sonority is justified because it includes markedness considerations in the form of a Sequential Markedness Principle (Clements 1990: 313).

Hancin-Bhatt & Bhatt (1997) also support the SDP because it explains the difficulty that their Spanish speaking informants found when producing –stop + glide- sequences. The claim that these are precisely the most difficult sequences for Spanish speaking learners of English is surprising. Firstly, because –stop + glide- sequences are not seen as a problem in the teaching of English pronunciation to Spanish speakers. Secondly, because we are not told what kind of errors they made. Hancin-Bhatt & Bhatt acknowledge that –stop + glide- sequences occur in Spanish, but they are analysed as a simple onset followed by a diphthong. The obvious question is: what

[2] I have simplified Clements' theory in the general discussion. In fact, he does not talk about onsets or codas. He uses the concept of 'demisyllable' as the basic unit for measuring syllable complexity. By demisyllable he means each of the two parts which result from the division of the syllable "into two overlapping parts in which the syllable peak belongs to both" (Clements 1990: 303). The preferred initial demisyllable has maximal and evenly distributed sonority differences, whereas the preferred final demisyllable has less sonority differences (or these are not evenly distributed).

difference does it make? Even if learners perform an 'erroneous' analysis of the –consonant + glide- sequence, does that have any real phonetic correlate? And, if so, is it noticeable? In our study we shall check whether these sequences are a problem for our learners and discuss the general problem of analysing glides as part of the onset or the nucleus both in English and Spanish.

4. Methodology

4.1 Goals

Firstly, we shall check whether acquiring a sequence which violates the sequencing constraint SONORITY entails a higher difficulty than acquiring one which just violates the language-specific configuration of O SON. This will provide valuable empirical support to the theoretical arguments in favour of keeping the two separate constraints and to OT learnability theory as a whole.

Secondly, we shall see whether –stop + glide- sequences are a problem for Spanish speaking learners of English. If this is the case, it will provide important evidence in favour of Clements' dispersion principle. Otherwise, it will show that there are few arguments to defend one approach to sonority or the other, specially on the grounds of the behaviour of glides.

4.2 Hypotheses

Hypothesis 1: Given two complex English onsets disallowed by the grammar of Spanish, Spanish speaking learners of English will perform significantly better with those which respect SONORITY.

Hypothesis 2: Spanish speaking learners of English will not find any difficulty in producing –stop + glide- sequences. If some difficulty is found, it will not be higher than that of the rest of complex onsets not allowed by the grammar of Spanish.

4.3 Informants

We selected five informants in their first year of an English Philology degree at the University of Murcia. None of them had ever been to an English speaking country at the time our study was conducted. Furthermore, we made sure that none of our informants had had any formal instruction in English apart from that provided by state schools. Their level could be defined as upper-intermediate given the standards of Spanish education and the additional instruction they had already received at University when our study was carried out. All of them had taken a twenty hour course which focused on Gimson's EPD-14 transcription system and were familiar with its symbols. They all volunteered to help us carry out our study.

4.4 Materials

We produced a list of monosyllabic nonsense words (Appendix A) accompanied by a phonetic transcription and a definition of the following type:

(1) stin [σστIνν] is an instrument used to mix liquids

The list included 38 items:

4 –stop + glide- sequences.
4 –stop + liquid- sequences.
4 –fricative + liquid- sequences.
4 –s + stop- sequences.

4 –s + liquid- sequences.
4 –s + glide- sequences.
14 fillers.

We also devised a "vocabulary test" (Appendix B) in order to elicit the words from the informants:

1. An instrument used to mix liquids is a...
a. stin [σστIνν] b. stig [σστIγγ] c. stid [σστIδδ]

4.5 Procedure

We used a slightly simplified version of Broselow and Finer's (1991) vocabulary learning test in order to elicit the words from our informants. First the researcher gives the informants a vocabulary list, telling them that they are going to participate in an experiment about the acquisition of new words in a second language. The vocabulary list consists of 38 sentences where a word is provided, followed by its EPD-14 transcription and an invented definition. The researcher reads each sentence and asks the informants to repeat it after him as a way to memorise the meaning of the words. This triple mode of presentation (spoken, written and transcribed) is defended by Broselow & Finer because it maximizes "the possibility that students really were attempting to produce the desired target phonemes rather than translating the English strings into the native language phoneme system; that is, to tease apart production and perception as sources of errors" (Broselow & Finer 1991: 40). No recording is carried out at this stage; we just aimed at providing some practice to avoid pronunciation mistakes due to external factors (lack of knowledge about the meaning of a particular phonetic symbol, for instance).

After this first 'memory' exercise, the informants were told that they were going to be tested. The test consisted of each one of the definitions they had 'memorised' followed by three possible choices, both in ordinary spelling and in phonetic transcription. All the choices for each question had exactly the same onset structure, so that even if the informant did not choose the correct word, the target cluster would be elicited. The researcher read each question and the three possible answers, to create again the "triple mode of presentation" situation. After that, the informants pronounced the one which they thought was the correct option. Their answers were tape-recorded using a Vivanco EM 116 clip-on microphone and an Aiwa TP-VS600 tape recorder. Subsequently the recordings were digitalised. The informants were told that their answers were going to be tape-recorded for two main purposes: firstly, to control the time they spent trying to recall the words and secondly to make the data gathering and analysis less time-consuming.

The words pronounced by each informant were then transcribed and analysed by the researcher. In cases of doubt (in particular, in -s+C- sequences-) acoustic analyses of the onsets were carried out, searching for periodic waveforms preceding the aperiodic patterns of the [s] which could betray the presence of a vowel-like element. We used the computer program PRAAT 3.9.5 for our analysis.

5 Results

We provide the raw results of our study in table 1. Perhaps one of the first things to comment on is the limited amount of errors which we have found. Most of our informants were probably well acquainted with the problematic of -s+C- sequences for Spanish learners of English and their performance was quite target-like (no considerations of the "quality" of [s] are made, only of its presence or absence). However, we found significant differences between the informants´production of -

s+stop- and -s+liquid- sequences, where -s+liquid- were produced more successfully (t_{obs}= 2.449, t_{crit}= 2.132, df = 4, p> .05). This confirms our first hypothesis: in spite of the fact that neither of the sequences is allowed by Spanish grammar, the one which violates SONORITY seems to be more difficult for Spanish learners of English. As for the difference between -s+glide- and -s+liquid- sequences, -s+glide- ones seem to be easier for Spanish learners of English as they produced them perfectly. However, the difference is not statistically significant (t_{obs} = 1, t_{crit} = 2.132, df =4, p> .05).

Table 1. Number of right (R) and wrong (W) productions in the pronunciation of our five informants depending on onset type

Informants and answers	1		2		3		4		5		TOTAL	
	R	W	R	W	R	W	R	W	R	W	R	W
stop + glide	4	-	4	-	4	-	4	-	4	-	20	-
stop + liquid	4	-	3	1	4	-	4	-	4	-	19	1
fric. + liquid	4	-	4	-	4	-	4	-	4	-	20	-
s + stop	2	2	4	-	3	1	4	-	4	-	16	4
s + liquid	3	1	4	-	4	-	4	-	4	-	19	1
s + glide	4	-	4	-	4	-	4	-	4	-	20	-

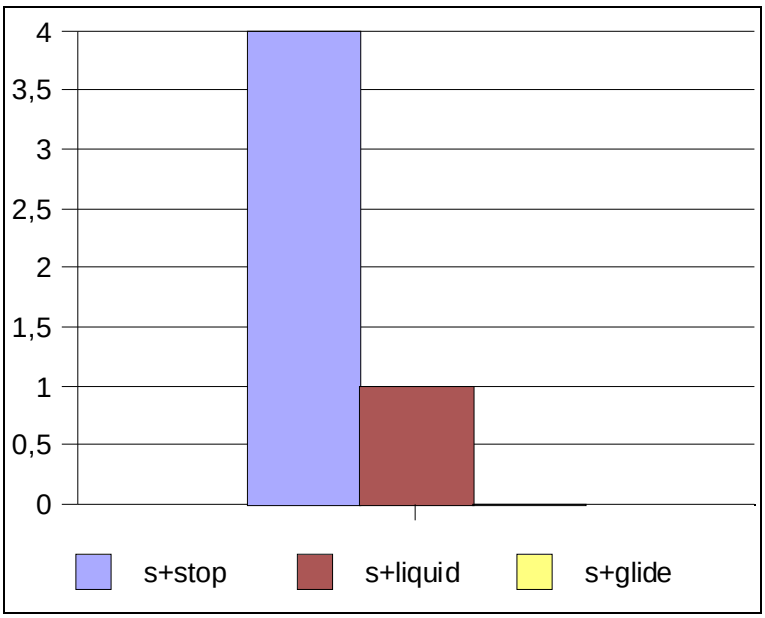

Figure 1. Total number of errors in the pronunciation of the different –s + C- sequences.

Finally, our informants scored better for -s+glide- sequences than for -s+stop- (t_{obs} = 2.138, t_{crit} = 2.132, df = 4, p> .05). The difference in the number of errors depending on the type of –sC- onset is represented in figure 1. As far as the second hypothesis is concerned, the complete absence of errors in –stop + glide- sequences is also confirmed, which contradicts Hancin-Bhatt and Bhatt's (1997) findings. –stop + glide- does not seem to be a problematic onset for Spanish speaking learners of English. Errors are also absent in the case of -fricative+liquid- sequences**.** We should also consider the fact that one of our informants produced one error in a -stop+liquid- sequence. More specifically, he produced the sequence /tr/ as a very close approximation to /τΣ/ (no epenthesis or deletion took place). We think that the problem was not phonotatic, but rather segmental. Two possible explanations may be suggested. First, that he perceived the affrication of -tr- sequences in English and identified it with a familiar affricate segment; a second alternative (which we favour) is to consider that the Spanish speaker trying to imitate the alveolar place of articulation of English [t] goes too far and transforms it into a palatalised affricate, thus dropping (or coalescing) the [r]. In fact, it is not such a strange phenomenon: a popular, often humorous interpretation of English pronunciation in Spanish turns English *two* into [τΣυ].

6 Interpretation and Discussion

6.1 Two types of onset constraints in L2 acquisition

We know that Spanish does not allow either –s + liquid- or –s + stop- onsets. From the viewpoint of the learner's L1, both are unacceptable. However, our data show that –s + liquid- seems to be easier than –s + stop- for our informants. This brings us back to the discussion of whether we should distinguish between two different sonority constraints: SONORITY, which affects the whole syllable and establishes a decreasing order of sonority from nucleus to margins and O SON, which just sets the minimal sonority distance between two segments occupying the same onset on a language-specific basis. Let us assume that both of them are present in the constraint hierarchy of Spanish. These are the relevant constraints:

SONORITY: A universal, markedness constraint which is high ranked in Spanish. All syllables must conform to a pattern of decreasing sonority from the nucleus to the margins.

O SON: (taken from Colina, 1995) A language-specific constraint which is assigned a sonority distance value. The sonority distance value for Spanish is 4.[3] We shall further assume that it will only take positive values. Thus it does not apply to a sequence such as [sp], which would have a –3.5 value.

CONTIGUITY: A faithfulness constraint that demands that elements which are contiguous in the input are also contiguous in the output. In practical terms, this implies that epenthesis will not take place between two segments in a complex onset.

MAX-IO: Another faithfulness constraint which demands that elements present in the input must have a correspondent in the output. In the case under study, it bans deletion as a way of simplifying complex onsets.

DEP-IO: A faithfulness constraint which demands that elements present in the output must have a correspondent in the input, i.e. a constraint which bans epenthesis.

*BR-ONSET: Branching onsets should be avoided (low-ranked in Spanish).

[3] We assume Selkirk's sonority scale: /a/ (10); /e, o/ (9); /i,u/ (8); /r/ (7); /l/ (6); /m, n/ (5); /s/ (4); /v, z, ∆/ (3); /f, T/ (2); /b, d, g/ (1); /p, t, k/ (0.5) (Selkirk 1984: 112).

We shall try to explain why the Spanish learner of English starts applying epenthesis to all –sC- sequences and then moves towards the target language forms following a given path, i.e. first –s + liquid- and then –s+ stop-. The initial constraint ranking which selects the epenthesis candidate is the following:

SONORITY, O SON(4) » MAX-IO, CONTIGUITY » DEP-IO » BR-ONSET

In other words, the worst onsets are those which violate either the universal principle of sonority sequencing ([sp], for instance) or the language-specific constraint O SON (a sequence such as [sl] in Spanish). Immediately below, the Spanish constraint hierarchy makes sure that two types of candidates can never win: firstly, those which show any type of deletion ([σπɛIv] pronounced as [σɛIv] or [πɛIv]); secondly, those which present epenthesis that breaks the contiguity relation between the two segments in the complex onset ([σπɛIv] pronounced as [σɛπɛIv]). The two least serious offences are epenthesis (provided that it is necessary) and the presence of branching onsets. Let us see how these constraints interact in (1) and (2) given two inputs /sp/ and /sl/ respectively.

(1) Initial hierarchy of the Spanish learner of English: epenthesis in –s + stop- sequences

/σπɛIv/	SONORITY	O SON	MAX	CONTIGUITY	DEP	*BR-ONS
σπɛIvπɛIv	*!					*
σɛπɛIvπɛIv				*!	*	
χσπɛIv			*!			
ɛσπɛIvɛσπɛIv					*	
ɛπɛIvπv			*!			

(2) Initial hierarchy of the Spanish learner of English: epenthesis in –s + liquid- sequences

/σlαIδ/	SONORITY	O SON	MAX	CONTIGUITY	DEP	*BR-ONS
α σlαIδσlαIδ		*!				*
β σɛlαIδɛlαI				*!	*	
χ σαIδσαIδ			*!			
σlɛσlαIδαIδ					*	
ɛ lαIδlαIδ			*!			

A word such as *Spain* violates a universal sequencing constraint SONORITY, whereas a word such as *slide* just violates a language-specific requirement. The question now is to suggest how this hierarchy can be 'fixed' so that Spanish speaking learners of English get closer to the target forms. It is necessary to consider the peculiar nature of O SON within OT because it can have different values (O SON= 1, 2, 3, 4...) whereas the usual thing is to find constraints which are either satisfied or violated, such as NO CODA or ONSET. This will have implications for OT's learnability theory in the form of constraint demotion (Tesar & Smolensky 2000). We cannot say that O SON is demoted below the other constraints in the learning process because that would entail undesired consequences: if we demote O SON in the learner's grammar, not only will it be possible to produce [sl] sequences, but also any other sequence (such as [pf] or [ts]) which does not violate SONORITY. In other words, demoting O SON does not result in the acquisition of [sl] onsets but rather in the suppression of any constraint regarding sonority distance in complex onsets.

Thus we have to assume that the learner tries different O SON values when interpreting overt learning data without demoting it. She makes the minimal change in the direction of markedness (say O SON=3) and applies interpretive parsing to a word such as *slide*.[4] By checking the phonetic form (ν= [σλαIδ]) and the result of applying production-directed parsing to the input / σλαIδ/ given the present grammar, she gets the following contrast:

What I perceive: [σλαIδ]
(interpretive parsing)

What I would produce given an input / σλαIδ / and O SON = 3: [εσλαIδ]
(production-directed parsing)

THUS there is a mismatch between learning data and grammar

Then the learner tries another minimal adjustment, i.e. O SON=2. By doing this she finds that what she perceives (ν) fits what she would produce given that input and her grammar (3).

(3) Modification of O SON: the target candidate is already regarded as optimal

/ σλαIδ /	SONORITY	O SON(2)	MAX	CONTIGUITY	DEP	*BR-ONS
σλαIδ α σλαIδ						*
σελαIδλα				*!	*	
σαIδσσαδ			*!			
εσλαIδε					*!	
λαIδ λαI			*!			

[4] We are following the Error-Driven Constraint Demotion algorithm (Tesar & Smolensky 2000).

The learner should also carry out another adjustment and reduce O SON to 1, so that sequences like *sn* and *sm* are allowed by her grammar. A basic idea In OT learnability theory is that all demotions affecting markedness constraints should me minimal. So far we have only been talking about 'adjusting', not demoting. Now we should face the problem of dealing with overt forms which violate SONORITY. In this case, the learner is not adjusting the value of a constraint, but applying Recursive Constraint Demotion (RCD), thus struggling against the principle of minimal alteration in the hierarchical status of markedness constraints. The learner is forced to apply RCD until he gets to the following hierarchy which selects the optimal candidate [εσπεIv] (4).

(4) Demotion of SONORITY: the target candidate is already regarded as optimal

/σπεIv/	O SON	MAX	CONTIGUITY	DEP	SONORITY	*BR-ONSET
εσπεIvεσπεI				*!		
σεπεIvσεπε			*!	*		
σπεIvσπεIv					*	*
πεIvπεIv		*!				

The markedness constraint SONORITY has to be demoted three times in order to obtain a ranking which allows onsets such as [sp]. If we consider the principle that markedness constraints should be demoted minimally, it will follow that acquiring onsets such as [sp] will incur a high cost, understood in terms of exposure and learning effort.

To sum up, the difference in difficulty of acquisition between –s + liquid- and –s + stop- cannot be explained in terms of L1 grammar. Our students do significantly better on –s + liquid – onsets because these do not violate any universal principle (SONORITY) but just a language-specific one (O SON). This can be explained in terms of OT learnability theory by establishing a contrast between changes in constraint configuration (O SON= 1, 2, 3, 4...) as opposed to constraint demotion. The latter will find a greater opposition in the learners' evolving grammar.

We are still left with one more question: why is there variation in the informants' production? In other words, how could we formalise the fact that we find both the epenthetic and target form coexisting in the speech of a learner? Here the concepts of strictness bands and gradual learning are essential (see Boersma 1997, 2000; Hayes 2000; Hayes & Boersma 2001). The constraints O SON and SONORITY should not be seen as units which are moved from one place to another, but rather as bands which are moving in relation to other bands (such as DEP). It is sensible to assume that before O SON has a stable value of 1 it will go through a stage where O SON= 2 and O SON=1 overlap, producing variability as the result of linguistic insecurity. The same applies to SONORITY: in its way to the stratum shared with *BR-ONSET, it will probably overlap with DEP. In this stage learners are likely to produce both epenthetic and target forms. This could well be the case of our first informant, who produced 2 –esC- and 2 –sC- sequences: in his IL DEP and SONORITY overlap. Presumably, he will eventually rank SONORITY below DEP, although fossilisation may take place before this happens.

6.2 Glides in English and Spanish and sonority models

As we have already pointed out, our data does not support Hancin-Bhatt & Bhatt's (1997) claims that –stop + glide- sequences are problematic for Spanish learners of English. We shall try to show that the ambiguous syllabic status of glides both in English and Spanish cannot provide evidence in favour of one sonority model or another. Let us start by discussing Hancin-Bhatt & Bhatt's (1997) remarks about glides in Spanish. They consider that Spanish speaking learners of English parse glides as part of the nucleus. However, even if we admit this statement, it is doubtful that this makes any difference from a phonetic viewpoint. As Laver points out, glides "are comparable to the syllable vocoids [...] in terms of location of the tongue body in the vocoid space and configuration of the lips but [...] differ both in their syllabic function and their timing characteristics" (Laver 1994: 297), that is to say, glides are vowels with shorter duration and non-syllabic function. It is quite doubtful that such a fine-grained difference could be regarded as an 'error' in the acquisition of the phonology of a second language.

However, there are even more important problems which should prevent us from making strong claims about –stop + glide- sequences. Their status in both Spanish and English is anything but clear. Hammond (1999) claims that sequences of the type –Cju- are not complex onsets in English, but simple onsets followed by a diphthong [ju]. He provides evidence from a language game called Pig Latin where players move a word-initial onset to the end of the word and add the vowel [e]. In table 2 we show some of the examples that he provides. The performance of his players was quite consistent, except for glides. Complex onsets of the type –Cw- (table 3) were moved in exactly the same way as those in table 2. –Cju- onsets (table 4), on the other hand, showed variation. Some speakers deleted the glide altogether (table 4, 2). Just a minority behaved in the expected way, thus moving the complex onset –Cj- and adding the [e] after the glide (table 4, 3). The overwhelming majority of players moved the first segment of the onset and left the glide-vowel sequence unaltered (table 4, 1). Hammond concludes that this tendency to move the consonant and leave the [ju] sequence in its original place reveals that it is in fact a diphthong, not an onset cluster.

Table 2. Examples of the 'Pig Latin' game adapted from Hammond (1999: 245)

Word	**English**	**'Pig Latin'**
cat	κHΘτκ {τ	ΘτκHε{τκ ε
Cathy	0κHΘTικ ι	0ΘTικHε{Τικε
brick	βρIκβρIκ	0Iκβρεικβρε
spot	σπΑτσπΑτ	0ΑτσπεΑτσπε
splat	σπλΘτσπλ{	0Θτσπλε{τσε

Table 3. The behaviour of –Cw- sequences in the speech of 'Pig Latin' players adapted from Hammond (1999: 245)		
Word	**English**	**'Pig Latin'**
queen	κHωινκ ωι	0ινκHωεινκ ε
quality	0κHω λ↔ριρι	0 λ↔ριικHωε ωε
Gwen	γωEνγωEν	0Eνγωε Eνγωε
guano	γωAνογνο	0Aνογωε Aνωε

Table 4. The behaviour of –Cju- sequences in the speech of 'Pig Latin' players according to the majority (1) and the two minority options (2,3). Adapted from Hammond (1999: 245)				
Word	English	1	2	3
cute	κHφυτκ φυτ	0φυτκHεφυτκ ε	0υτκHευτκ ε	0υτκHψε ψε
cupid	κHφυπ↔δπ≅δ	0φυπ↔δκHεκ ε	0υπεδκHε ε	0υπεδκHψεε
puce	ππHφυσ φσ	0υσπHεφυσπ ε	0φυσπHευσπε	0υσπHψε φε

This description may be enough to discourage us from any attempt of making strong statements about the relative markedness of –stop + glide- sequences. It might be suggested, however, that the nature of Spanish glides as part of a diphthong is not arguable. Unfortunately, this is not true. The role of 'semivowels' and 'semiconsonants' in Spanish phonology has been a matter of discussion for decades and even today it remains an open issue (see Monroy (1980) for a complete overview of the treatment of glides in Spanish phonetics and phonology over the last century).

Let us take the example of two (apparently) identical diphthongs: *pierna* ('leg') and *hierba* ('grass'). The spelling may suggest the presence of two identical nuclei [je]: [pjérna, jérba]. However, this is not the traditional interpretation of Spanish phoneticians. Quilis & Fernández (1992: 98) suggest that *–ie-* in *pierna* should be interpreted as a diphthong ([pjérna]), whereas in *hierba* we do not get a complex nucleus but a voiced palatal fricative [j] followed by the nuclear vowel [e]. This curious situation is shown graphically in figure 2.

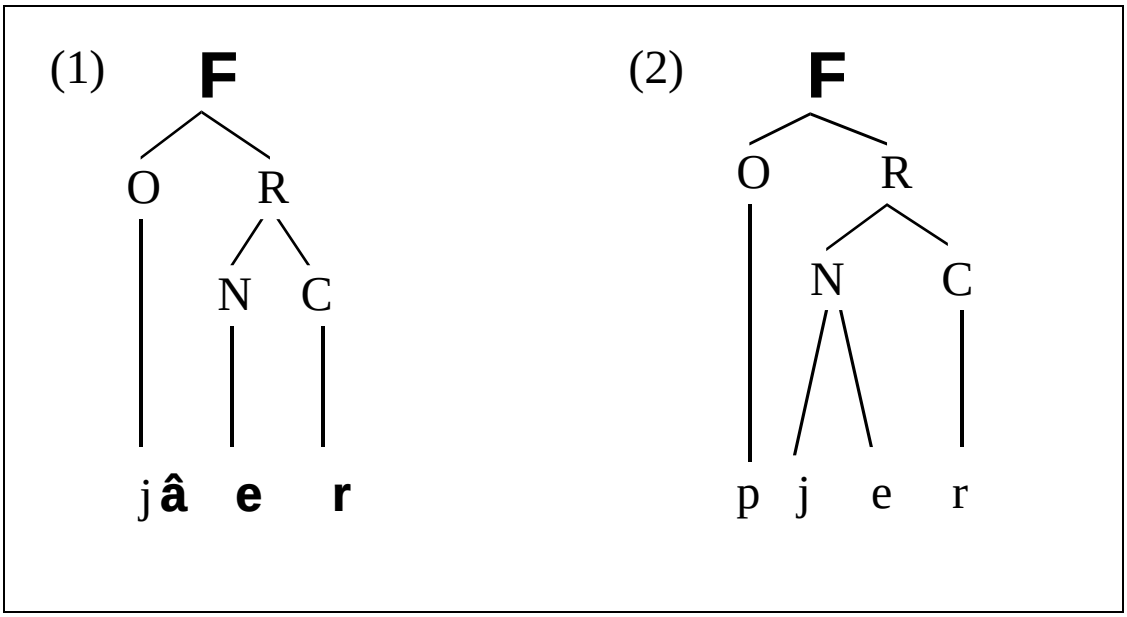

Figure 2. Representation of the structure of the first syllable in the Spanish words 'hierba' and 'pierna'

A similar situation is found in the case of [w]. It can be a part of what has been traditionally interpreted as a word-initial diphthong: *huerta, huevo* [wérta, wéBo] ('orchard', 'egg') but very often in these cases the word-initial glide undergoes a velar reinforcement, so that the phrase *la huerta* ('the orchard') is pronounced [lAAΦωérta] in the informal speech of many Spanish speakers.

To summarise the status of glides in Spanish, they are part of a complex nucleus whenever they are preceded by a consonant, i.e. when the onset position is already occupied – like in *pierna* ('leg') or *muerto* ('dead') –. Word-initially, however, they tend to be parsed as syllable onsets. It is a widely held idea in OT that onsetless syllables are more marked than CV ones. Consequently, parsing the glide as an onset is more harmonic than analysing it as part of a complex nucleus. However, glides are not allowed to occupy the onset position in Spanish (B_{Ons}= /l, r/). This problem is solved by increasing the degree of constriction to the airflow, so that we get a fricative-like sound which does not violate the onset associational constraint. The modification affects manner of articulation – thus violating IDENT-IO(manner) – but it respects the place of articulation of the original glides – respecting IDENT-IO (place) –.

This is just a sketch of a complete account of Spanish glides, but it illustrates to what extent all attempts to defend either Selkirk or Clement's approaches to sonority on the grounds of the behaviour of glides are problematic.

The same logic applies to Broselow & Finers' (1991) study about Korean learners of English. Regardless of the status of glides in this language, the truth is that –py- seems to be an easy combination of sounds for them. New approaches to sonority may be needed in order to shed light on this issue.

6.3 Alternatives to syllable and sonority-based phonotactics

There have been attempts to explain phonotactic constraints without explicit reference to the traditional concepts of 'sonority' and 'syllable'. Ohala & Kawasaki (1997) suggest that sonority should be substituted by the consideration of different acoustic parameters. The basic idea is that those combinations which involve higher modulation of the carrier signal are better than those characterised by lack of change:

> Rather than focus on some alleged intrinsic value that individual speech sound or sound types are supposed to have, we should concentrate on the *modulations* in the relevant parameters created by concatenating one speech sound with another [… We should] define the degree of "goodness" of these acoustic modulations as proportional to the length of the trajectory it makes through the acoustic space whose dimensions are the acoustic parameters listed above. (Ohala & Kawasaki 1997: 349-350)

Steriade (1997, 1999) provides a similar account which emphasises the perceptual basis of phonotactic constraints. She claims that "the well-formedness of a segment sequence can and should be characterized in terms of relative perceptibility and not in syllable-sensitive terms" (Steriade 1999: 238). These alternative accounts of phonotactics and sonority are still tentative. Thus, they do not provide (yet) full accounts of phonotactics which could leave out sonority and syllable-based constraints altogether. Nevertheless, they can provide an explanation to the 'goodness' of –py- as a sequence regardless of the syllabic status of the glide. The change from 'p' to 'y' involves a whole range of modulations to the carrier signal across a variety of acoustic parameters. Furthermore, the acoustic cues projected by the two sounds do not mask each other, thus making both sounds easily perceptible. In simpler words, the two sounds combined are different enough to produce a contrast which is easily perceived by the hearer. In principle, this could account for the relative ease of acquisition of these sequences avoiding the reference to different sonority models.

7 Conclusion

We have discussed the results of a research study which focused on the acquisition of some English complex onsets by Spanish-speaking learners. Firstly we argue that the difference in difficulty between –s + liquid- and –s + stop- onsets (both disallowed by Spanish phonology) can be interpreted as the result of the violation of different constraints. –s+liquid- violates a language-specific configuration (O SON) whereas –s + stop- violates a universal sequencing constraint (SONORITY). We explain this difference in difficulty with reference to OT learnability theory, distinguishing between alterations in sonority distance settings and the demotion of universal markedness constraints.

We have also offered a different view on what could be called the 'glide controversy' in the acquisition of onsets. Our data contradict Hancin-Bhatt & Bhatt's (1997) remarks about the alleged difficulty of –stop + glide- sequences for Spanish-speaking learners of English. We go even further, claiming that there is no clear way to distinguish between the role of glides as part of a complex onset or a complex nucleus either in English or in Spanish. Consequently, glides can offer no evidence in favour of one sonority model or another and the whole controversy loses much of its sense.

We also talk about an alternative approach to phonotactics and sonority based on acoustic and perceptual criteria. This theory entails important consequences for research in second language phonology. Firstly, the consideration of a purely linear approach to the constraints affecting segment combination implies the rejection of any discussion based on the traditional notion of sonority. Consequently, the distinction between O SON and SONORITY would no longer be needed. Secondly, it provides a valuable explanation to the ease of acquisition of –stop + glide- sequences avoiding controversial statements based on different sonority theories.

Second language phonology research depends quite heavily on the developments of general phonological theory. Quite probably L2 researchers are not happy with the existing idea of sonority, but there is no other choice until we are provided with an alternative, suitable model of phonotactics. This type of 'primary' (as opposed to 'applied') linguistic work requires extensive perceptual and acoustic study of different

segment combinations which is outside the scope of study of L2 phonology. Until these developments are carried out, we are just left with a few tentative explanations to be applied to our field of study. In spite of these problems, the idea of phonotactics understood independently of concepts such as 'sonority' or even 'syllable' offers exciting perspectives for future research.

References

Anderson, Janet (1987): "The markedness differential hypothesis and syllable structure difficulty". In: Ioup, Georgette & Weinberger, Steven (eds.): *Interlanguage phonology: The acquisition of a second language sound system*. New York: Newbury House, 279-291.

Benson, Bronwen (1986): "The markedness differential hypothesis: Implications for Vietnamese speakers of English". In: Eckman, Fred R., Moravcsik, Edith A. & Wirth, Jessica A. (eds.): *Markedness*. New York: Plenum Press, 271-289.

Boersma, Paul (1997): "How we learn variation, optionality and probability". ROA-221.

Boersma, Paul (2000): "Learning a grammar in functional phonology". In: Dekkers, Joost, van der Leeuw, Frank & van de Weijer, Jeroen (eds.): *Optimality Theory: Phonology, syntax and acquisition*. Oxford: OUP, 465-523.

Broselow, Ellen (1984): "An investigation of transfer in second language phonology". *IRAL* 22, 253-269.

Broselow, Ellen (1987): "Non obvious transfer on predicting epenthesis errors". In: Ioup, Georgette & Weinberger, Steven (eds.): *Interlanguage phonology: The acquisition of a second language sound system*. New York: Newbury House, 261-278.

Broselow, Ellen, Chen, Su-I & Wang, Chilin (1998): "The emergence of the unmarked in second language phonology". *Studies in Second Language Acquisition* 20, 261-280.

Broselow, Ellen & Finer, Daniel (1991): "Parameter setting in second language phonology and syntax". *Second Language Research* 7, 35-59.

Carlisle, Robert (1988): "The effects of markedness on epenthesis in Spanish/English interlanguage phonology". *Issues and Developments in English and Applied Linguistics* 3, 15-23.

Carlisle, Robert (1994): "Markedness and environment as internal constraints on the variability of interlanguage phonology". In: Yavas, Mehmet (ed.): *First and second language phonology*. San Diego, CA: Singular, 223-249.

Cichoki, W., House, A.B., Kinloch, A.M. & Lister, A.C. (1999): "Cantonese speakers and the acquisition of French consonants". In: Leather, Jonathan (ed.): *Phonological issues in language learning*. Oxford: Blackwell, 95-121.

Clements, George N. (1990): "The role of the sonority cycle in core syllabification". In: Kingston, John. & Beckman, Mary E. (eds.): *Papers in laboratory phonology I*. Cambridge: CUP, 283-333.

Colina, Sonia (1995): *A constraint-based analysis of syllabification in Spanish, Catalan and Galician*. Unpublished PhD dissertation, University of Illinois, Urbana-Champaign.

Dickerson, L. (1975): "The learner's interlanguage as a system of variable rules". *TESOL Quarterly* 9, 401-407.

Dulay, Heidi & Burt, Marina (1974): "Natural sequences in child second language acquisition". *Language Learning* 24, 37-53.

Eckman, Fred (1977): "Markedness and the contrastive analysis hypothesis". *Language Learning* 27(2), 315-330.

Eckman, Fred (1984): "Universals, typologies and interlanguage". In: Rutherford, William E. (ed.): *Language universals and second language acquisition*. Amsterdam: John Benjamins, 79-105.

Eckman, Fred (1987): "The reduction of word-final consonant clusters in interlanguage". In: James, Allan & Leather, Jonathan (eds.): *Sound patterns in second language acquisition*. Providence, RI: Foris, 143-162.

Eckman, Fred & Iverson, Gregory (1993): "Sonority and markedness among onset clusters in the interlanguage of ESL learners". *Second Language Research* 9(3), 234-252.

Edge, B. (1991): "The production of word-final voiced obstruents in English by L1 speakers of Japanese and Cantonese". *Studies in Second Language Acquisition* 13, 377-393.

Hammarberg, B. (1990): "Conditions on transfer in phonology". In: Leather, Jonathan & James, Allan (eds.): *New Sounds 90: Proceedings of the 1990 Amsterdam Symposium on the Acquisition of Second Language Speech*. Amsterdam: University of Amsterdam, 198-215.

Hammond, Michael (1999): *The phonology of English: A prosodic optimality-theoretic approach*. Oxford: OUP.

Hancin-Bhatt, Barbara (2000): "Optimality in second language phonology: Codas in Thai ESL". *Second Language Research* 16(3), 201-231.

Hancin-Bhatt, Barbara & Bhatt, Rakesh (1997): "Optimal L2 syllables: Interactions of transfer and developmental effects". *Studies in Second Language Acquisition* 19, 331-378.

Hayes, Bruce (2000): "Gradient well-formedness in Optimality Theory". In: Dekkers, Joost, van der Leeuw, Frank & van de Weijer, Jeroen (eds.): *Optimality Theory: Phonology, syntax and acquisition*. Oxford: OUP, 88-120.

Hayes, Bruce & Boersma, Paul (2001): "Empirical tests of the gradual learning algorithm". *Linguistic Inquiry* 32(1), 45-86.

Ioup, Georgette (1984): "Is there a structural foreign accent? A comparison of syntactic and phonological errors in second language acquisition". *Language Learning* 34, 1-17.

James, Carl (1980): *Contrastive analysis*. London: Longman.

Lado, Robert (1957): *Linguistics across cultures*. Ann Arbor, MI: University of Michigan Press.

Laver, John (1994): *Principles of phonetics*. Cambridge: CUP.

Major, Roy (1987): "A model for interlanguage phonology". In: Ioup, Georgette & Weinberger, Steven (eds.): *Interlanguage phonology: The acquisition of a second language sound system*. New York: Newbury House, 101-124.

Major, Roy & Kim, Eunyi (1999): "The similarity differential rate hypothesis". In: Leather, Jonathan (ed.): *Phonological issues in language learning*. Oxford: Blackwell, 151-183.

Monroy Casas, Rafael (1980): *Aspectos fonéticos de las vocales españolas.* Madrid: SGEL.

Ohala, John & Kawasaki-Fukumori, Haruko (1997): "Alternatives to the sonority hierarchy for explaining segmental sequential constraints". In: Eliasson, S. & Jahr, E.H. (eds.): *Studies for Einar Haugen*. Berlin: Mouton de Gruyter, 343-365.

Prince, Alan & Smolensky, Paul (1993): *Optimality Theory: Constraint interaction in generative grammar*. Manuscript, Rutgers University and the University of Colorado at Boulder.

Quilis, Antonio & Fernández, Joseph (1992): *Curso de fonética y fonología españolas* (14th edition). Madrid: CSIC.

Riney, T. (1990): "Age and open syllable preference in interlanguage phonology". In: Burmeister, H. & Rounds, P. (eds.): *Variability in second language acquisition: Proceedings of the 10th meeting of the Second Language Research Forum* (vol. 2). Eugene, OR: Dept. of Linguistics, University of Oregon, 655-666.

Sato, Charlene (1987): "Phonological processes in second language acquisition: Another look at interlanguage syllable structure". In: Ioup, Georgette & Weinberger,

Steven (eds.): *Interlanguage phonology: The acquisition of a second language sound system*. New York: Newbury House, 248-260.

Selkirk, Elisabeth (1984): "On the major class features and syllable theory". In: Aronoff, Mark & Oehrle, Richard T. (eds.): *Language sound structure*. Cambridge, MA: MIT Press, 107-136.

Steriade, Donca (1997): "Phonetics in phonology: the case of laryngeal neutralization". Available on the web, http://www.linguistics.ucla.edu/people/steriade/steriade.htm.

Steriade, Donca (1999): "Alternatives to syllable-based accounts of consonantal phonotactics". In: Fujimura, O., Joseph, B.D. & Palek, B. (eds.): *Proceedings of LP'98*. Prague: The Karolinum Press, 205-245.

Tarone, Elaine (1978): "The phonology of interlanguage". In: Richards, Jack C. (ed.): *Understanding second and foreign language learning*. Rowley, MA: Newbury House, 15-33.

Tarone, Elaine (1980): "Some influences on the syllable structure of interlanguage phonology". *IRAL* 18(2), 139-152.

Tesar, Bruce & Smolensky, Paul (2000): *Learnability in Optimality Theory*. Cambridge, MA: MIT Press.

Tropf, Herbert (1987): "Sonority as a variability factor in second language phonology". In: James, Allan & Leather, Jonathan (eds.): *Sound patterns in second language acquisition*. Providence, RI: Foris, 173-191.

Weinberger, S. (1987): "The influence of linguistic context on syllable simplification". In: Ioup, Georgette & Weinberger, Steven (eds.): *Interlanguage phonology: The acquisition of a second language sound system*. New York: Newbury House, 401-417.

Yavas, Mehmet (1994): "Final stop devoicing in interlanguage". In: Yavas, M. (ed.): *First and second language phonology*. San Diego, CA: Singular, 267-282.