SSLA, **19**, 331–378. Printed in the United States of America.

OPTIMAL L2 SYLLABLES

Interactions of Transfer and Developmental Effects

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This paper provides evidence from a study of ESL speakers that cross-language transfer effects interact, sometimes in very subtle ways, with developmental effects in the construction of L2 syllable structures. It extends Broselow and Finer's (1991) proposal for the Minimal Sonority Distance Parameter-Setting (MSD) model in L2 syllables by (a) adding evidence from a language that unambiguously exhibits transfer in complex onsets and (b) examining syllable codas to see whether the MSD parameter can be extended to account for the distribution of error patterns there, as well. The results of the study generally support the predictions that the MSD model makes for consonant cluster difficulty in specific syllable positions; however, it does not make predictions about the patterns that are found in learner error types. We argue that optimality theory (Prince & Smolensky, 1993) provides a more explicit account of the interactions between transfer and developmental effects in L2 syllables, allowing us to interpret within a singular grammatical

We thank the enthusiastic volunteers from the University of Tennessee and the University of Illinois who served as subjects in this study, as well as their instructors, Toby Guebert and Leslie LeChance, who helped in the recruiting. We also thank Sonia Colina for readily sharing her work on Spanish phonology, especially her doctoral dissertation, with us and for insightful comments on an earlier draft. This paper benefited greatly from the valuable comments of several anonymous reviewers. Any errors are, of course, our own. This paper is an extended version of a paper given at SLRF '95, and we thank that audience for their comments and discussions as well. Finally, we gratefully acknowledge the financial support for this project from the University of Tennessee, Department of English Hodges Fund.

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https://doi.org/10.1017/S0272263197003033 Published online by Cambridge University Press

framework not only *why* learners have difficulty with specific ESL structures but also *how* they resolve it.

Cross-language transfer, or the use of first language (L1) linguistic structures in second language (L2) speech, has been shown to be a prominent factor affecting L2 phonology acquisition (e.g., Bhatt, 1995; Broselow, 1983, 1984; Hancin-Bhatt, 1994b; Hancin-Bhatt & Bhatt, 1992; Hodne, 1985; Sato, 1983; Tarone, 1976, 1980; Weinberger, 1990). Studies exploring transfer have provided two major qualifications to these effects: (a) cross-language transfer is more prevalent in early stages than in later stages of acquisition (e.g., Major, 1986, 1987, 1994), and (b) developmental effects, which we define as the universal processes or constraints on linguistic complexity such that certain structures are learned more easily than others (cf. Eckman, 1977, 1987, 1991), interact with cross-language transfer (e.g., Archibald, 1993; Flege & Davidian, 1984; Major, 1987), thereby introducing an additional variable into the equation defining interlanguage grammar. Although the empirical evidence is substantial, studies that ground these effects within a linguistic-theoretic framework are few (see Leather & James, 1991, for a review), a fact that limits our understanding of transfer within an explanatory model of L2 acquisition. In this paper, we provide empirical evidence to show that both cross-language transfer and developmental constraints govern syllable structures in English as a second language (ESL), and we further show how the interaction of these main effects is best interpreted within the grammatical framework known as optimality theory (OT) (Prince & Smolensky, 1993).

The basic outline of the paper is as follows. We first review two recent linguistic-theoretic analyses of ESL syllable structures that provide strong evidence of developmental effects in acquisition. We show that only one of the proposals, namely, Broselow and Finer's (1991) Minimal Sonority Distance Parameter-Setting model (MSD model), provides a formal account of transfer as it interacts with these effects. The second analysis, that of Eckman and Iverson (1993), points out that the evidence to support the parameter-setting model was weak and, thus, diminishes the need to formally account for transfer in acquisition. We then present our own study of 20 Japanese and Spanish speakers of ESL to test more carefully the predictions of the parameter-setting model, not only on complex syllable onsets, as was done in the two previous studies, but also on codas. Our results strongly suggest that transfer interacts with developmental errors, not only in terms of the structures on which learners err but also in terms of how they err. Because the parameter-setting model, in its current form, does not make predictions on language-specific phonotactics, nor does it predict systematic error types, we argue that an alternative grammatical framework that accommodates the empirical coverage reported in this study, as well as Broselow and Finer's initial insights, is OT.

In the final section of this paper, we present an optimality-theoretic approach to the L2 grammar, briefly introducing the theory, providing example analyses of (native) Spanish and Japanese syllable structure, and then showing how OT can

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Table 1. Sonority scale (Broselow & Finer, 1991, p. 38)

Class	Value
stops	1
fricatives	2
nasals	3
liquids	4
glides	5

account for transfer and developmental effects in the ESL of our Japanese and Spanish learners. We specifically discuss in what ways OT goes beyond the MSD model not only in accounting for patterns in learners' error types, but also in providing a well-defined theoretical framework within which to ground future studies on interlanguage phonology.

RECENT PROPOSALS ON ESL SYLLABLE STRUCTURE ACQUISITION

Two recent linguistic-theoretic proposals have provided important insight into the development of L2 syllable structures, which have led to the hypotheses for the experimental study reported here. In this section, we discuss the contributions these two proposals have made to our current understanding of L2 syllable structures, particularly with respect to explaining transfer and developmental effects. We then discuss how we used these insights to design our own experimental study to add to the debate on using linguistic theory to account for effects observed in L2 sound patterns.

The MSD Model: Transfer and Developmental Effects

Adopting a principles and parameters framework, Broselow and Finer (1991) argued for the relative importance of both transfer and developmental effects in the acquisition of consonant clusters in syllable onsets. Focusing on empirical generalizations of sonority sequencing—that is, that onsets exhibit rising sonority, whereas codas exhibit falling sonority—they argued that ESL speakers' cluster acquisition is constrained by first language sequencing possibilities and by universal constraints on sequencing. Broselow and Finer introduced the multivalued minimal sonority distance (MSD) parameter (Selkirk, 1982) as the critical determinant in L2 syllable acquisition. The MSD parameter allows us to characterize variation in cluster sequencing based on the degree of sonority difference that must be present between adjacent segments. Consider the following sonority scale with the set of hypothetical values in Table 1.

If a language has a setting of 5, then it does not allow consonant clusters because the largest allowable difference between consonantal-type values is 4. If a language has a setting of 3, then it allows any cluster that has at least a difference of 3, so it

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allows –stops + liquids–, –stops + glides–, and –fricatives + glides–. Broselow and Finer account for difficulties in learning L2 consonant clusters by proposing that learners transfer the MSD parameter setting of their L1 into their L2. They claim that onset (and coda) sequences with a lower MSD setting than the learners' L1 will be difficult to acquire. Furthermore, the lower the MSD of the two consonants, the more difficult the cluster is to acquire due to principled constraints on sonority sequencing in the grammar. Namely, grammars prefer a larger, rather than smaller, difference in sonority between two consonants in complex syllable structure. In this way, the MSD accounts for developmental effects in complex syllables via generalizations on sonority sequencing and for transfer effects via assumptions that all languages select a particular setting and that this setting is transferred into the initial state of L2 acquisition.

The results of Broselow and Finer's study on 32 Japanese and Korean speakers of ESL generally supported the predictions of the MSD. Their subjects studied pseudo- and low-frequency English words, specifically designed to manipulate the target complex onsets. They were then given a vocabulary test. Data were gathered from two repetitions in the study session and another repetition in the test session. Although the number of errors in their data was small, there is an upward trend in error rate as the sonority difference between the clustered sounds decreased. For example, –consonant + glide– onsets (–Cy–) had a lower error rate than –consonant + liquid– (–Cr–) onsets. Also, their subjects had greater difficulty with –fricative + liquid/glide– onsets than with –stop + liquid/glide– ones. Broselow and Finer interpreted their results within the MSD model by concluding that their subjects had converged upon an MSD setting that was an intermediate value between the native and target language settings. That is, the MSD model can predict (a) which L2 syllable structures should be initially easy for the learner due to transfer and (b) of the unacquired structures which will be more difficult to acquire universally due to constraints on sonority sequencing.

Typological Markedness: Developmental Effects

Eckman and Iverson (1993), however, argued against the need for the MSD parameter in characterizing cluster acquisition differences in ESL syllables. One major problem they pointed out is the assumption that difficulty is based solely on sonority sequencing. In particular, they showed that sonority sequencing by itself made incorrect predictions about the occurrence of –C + glide– onsets in languages that have –C + liquid– ones. Some languages, like German (and Spanish), allow the latter onsets but not the former (Eckman & Iverson, 1993, p. 250). In addition, they pointed out that if, as Broselow and Finer argued, Japanese and Korean could be shown to have –Cy– clusters in onset position, a controversial claim, then the languages could also be shown to have –nasal + glide– sequences, as suggested by the following data: Korean [myən] "cotton," [nwi] "chaff"; and Japanese [myo:] "strange," [nyo:] "urine" (Eckman & Iverson, 1993, p. 239). If these languages have –nasal + glide– onsets, they should have an MSD setting of 2. But with a setting of 2, the language should in principle allow a large range of consonant clusters (–stop + glide–,

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–fricative + liquid–, –stops + liquids–, etc.), and this is not the case (for Japanese, see Vance, 1987; for Korean, see Sohn, 1987). Eckman and Iverson argued, then, that the MSD model overgenerates because the range of structures actually observed in these two languages is much smaller.

Eckman and Iverson argued that Broselow and Finer's data could be explained by typological markedness, in concert with the Sonority Dispersion Principle (Clements, 1990), and that there was no evidence to complicate their analysis with discussions of language transfer in the MSD parameter setting, especially in light of the –C + glide– controversy. They claimed that sonority sequencing generalizations were better captured by Clements' (1990) theorem of sequential markedness, which states relative markedness relationships between sounds. Fricatives are marked relative to stops, and voiced obstruents are marked relative to voiceless ones. According to the markedness differential hypothesis (MDH) proposed in Eckman (1977), marked structures are more difficult to acquire than unmarked ones, thus predicting that the more marked –voiced obstruent + liquid/glide– onsets are more difficult to acquire than the less marked –voiceless obstruent + liquid/glide– ones. Additionally, –voiceless fricative + liquid/glide– onsets are more difficult than the –voiceless stop + liquid/glide– ones (Eckman & Iverson, 1993, p. 242). They also posited that –stop + glide– clusters are more difficult than –stop + liquids– because, according to Clements' (1990) sonority dispersion principle, there is a more severe (upward) slope in sonority in the first set than in the second, making the former more marked relative to the latter. Thus, according to Eckman and Iverson, relative difficulty of cluster sequences is purely a function of typological markedness.

Eckman and Iverson supported their proposal with data from the three cluster types in 11 ESL speakers of Korean, Japanese, and Cantonese. Their data came from a set of conversations one of the experimenters had with the subjects, so the rate of consonant cluster attempts was not controlled for as in the Broselow and Finer study. The results indicated that in 92% of the test cases the subjects' production of complex onsets was consistent with their markedness-based predictions (Eckman & Iverson, 1993, p. 247). They pointed out that the cases that did not appear to obey markedness relations were probably examples of transfer by their two Cantonese speakers. In short, then, their analysis essentially discounted the role of L1 effects in L2 acquisition by these speakers and attributed practically all of the variation in acquisition to typological markedness effects.

In both of the preceding approaches, the researchers attributed most of the variation in ESL syllable structure acquisition to developmental effects based on markedness in sonority sequencing. The role of transfer in each approach was interpreted quite differently. In the Broselow and Finer account, what transferred was the MSD parameter setting from the L1 into the L2. Thus, for their Japanese and Korean learners, transferring a high MSD setting (one that essentially prohibits consonant cluster onsets) into English resulted in negative transfer, forcing learners to have to learn all cluster onsets, which are more or less difficult depending on sonority sequencing. However, their evidence did not provide a strong argument for transfer, as pointed out in Eckman and Iverson, because their subjects were not able to transfer many complex onsets from their L1. The question remains: Is the diffi-

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Table 2. Japanese and Spanish onset and (word-final) coda inventories

	Spanish		Japanese	
Consonants	Onsets	Codas	Onsets	Codas
C	All C	/n/, /l/, /r/, /s/, /d/	All C	/n/
CC	/pr/, /br/, /tr/, /dr/, /fr/, /fl/, /kr/, /kl/, /gr/, /gl/	*	*	*

culty due to a transferred parameter setting or solely to principles of Universal Grammar? In the Eckman and Iverson account, the difficulty that these language learners had was practically all attributed to principles of UG, and the small effect of transfer they observed was left formally unaccounted for within their approach. In short, with these two analyses, we have evidence of a strong role for developmental effects in syllable acquisition and a minimal role for transfer.

Motivations for the Current Study

The evidence presented in the two preceding studies, however, does not accurately represent the role of transfer and how it interacts with developmental effects in L2 phonology. Studying Japanese and Korean subjects does not provide strong evidence of cross-language transfer in cluster onsets because these languages arguably do not have such onsets. The motivation for our study was to test the MSD model more carefully than had been done previously not only by examining a set of speakers that can unambiguously transfer complex onsets but also by extending the predictions on sonority sequencing to the syllable coda position. Thus, we proposed to study more fully the extent to which transfer effects interact with developmental ones in ESL syllable structures. In this way, this study goes beyond the two previous studies because (a) they did not examine ESL speakers whose native language could uncontroversially exhibit transfer in complex onsets and (b) they only examined syllable onsets, not codas.

The two language groups that we chose to study were Spanish and Japanese learners of ESL. We chose Japanese speakers primarily because this group was included in both of the previously discussed studies and we wanted to ensure some level of comparability across all three studies. As can be seen in Table 2, Japanese does not have complex onsets or codas (Vance, 1987), so, as stated earlier, we should see only evidence of a developmental trend in onset and coda cluster acquisition. We chose Spanish as a language that should exhibit specific evidence of (positive) transfer. As shown in Table 2, Spanish allows certain biconsonantal onsets, like English, so if transfer occurs there should be a facilitative effect for the like onsets. For codas, however, Spanish does not allow complex codas word finally (Harris, 1983),[1] so we should see the developmental effects constraining their production.

Like Eckman and Iverson, we will assume that Japanese does not have complex onsets, including –C + glide–. Additionally, we assume that Spanish does have com-

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plex onsets, but not of the type –C + glide–.[2] Because Spanish has –fricative + liquid– onsets, it must have an onset MSD setting of 2.[3] Japanese, however, has a setting of 5, because it does not allow complex onsets. If these settings are transferred into English, then we hypothesize the following:

> Hypothesis 1: Spanish speakers make fewer errors on English –stop + liquid– and –fricative + liquid– clusters than Japanese speakers, due to the transfer of their native MSD parameter settings into English.

In terms of developmental effects, the MSD model predicts that –stop + glide– onsets should be easier to acquire than –stop + liquid– onsets, which, in turn, are easier than –fricative + liquids–, due to the reduction of the difference in sonority across the three sets of onsets. Overall, then, we should observe developmental effects as follows:

> Hypothesis 2: For all speakers, there is a higher error rate in –fricative + liquid– onsets (MSD setting: 2) than in –stops + liquids– (MSD setting: 3). For Japanese speakers, these two have higher error rates than in the –stop + glides– (MSD setting: 4).

Furthermore, because the sonority sequencing generalizations hold over both margins of the syllable, onset and coda, then we should be able to extend the predictions of the MSD to the coda domain. Whereas the two previous studies looked at onsets only, we wanted to observe the extent to which the MSD specifically (i.e., generalizations on sonority sequencing) would hold in L2 complex coda acquisition as well, particularly because there are much greater restrictions on coda licensing in Spanish and Japanese than in English, as can be seen in Table 2. In terms of word-final codas, neither Spanish nor Japanese allows complexity, so these languages should have a coda setting of 5. This predicts that there will be no transfer effects in complex L2 codas for these two language groups. The MSD model does predict, however, developmental effects. Thus, clusters with a smaller sonority distance should be more difficult to acquire, so we posit the following:

> Hypothesis 3: For all learners, there is a higher error rate in –liquid + nasal– codas (MSD setting: 1) than in –liquid + fricatives– (MSD setting: 2), which, in turn, have a higher error rate than in –liquid + stops– (MSD setting: 3).

STUDY ON CONSONANT CLUSTERS IN ESL ONSETS AND CODAS

The purpose of this experiment was to test the preceding predictions of the MSD model of Broselow and Finer (1991), the singular grammatical framework currently available, which allows us to examine the interaction of transfer and developmental effects in L2 learners' complex syllable onsets and codas.

https://doi.org/10.1017/S0272263197003033 Published online by Cambridge University Press

Table 3. Summarized profile of ESL subjects: Spanish and Japanese ESL averages

Subjects (N = 20)	Age	Years Studied English	Months in U.S.	% Correct Task 2
Spanish (10)	29.2	4.4	2.4	72.4
Japanese (10)	19.8	6.8	10.2	84.7

Methodology

Subjects. Participants in this study were 10 Japanese speakers and 10 Spanish speakers enrolled in intensive English summer programs in the beginning and intermediate levels. Table 3 gives a summary of the language learning background of the subjects. Appendix A provides a more detailed description of each subject.

Overall, subjects began their English learning in adolescence or older, so we consider them to be adult learners. The average number of years studying English for the Spanish group was 4.4, and for the Japanese it was 6.8. The average number of months in the second language environment (U.S.) was 2.4 for the Spanish speakers and 10.2 for the Japanese speakers. In the final column, we show the rate of accuracy on a grammaticality judgment task (Task 2 described later) by our subjects. On average, the Spanish subjects performed at 72.4% accuracy, whereas the Japanese speakers performed at 84.7% accuracy. Based on these self-reports and the grammaticality judgment task, the Japanese group was of a slightly higher proficiency than the Spanish group.

Items. We designed a set of 72 pseudo-English words that were monosyllabic and that varied according to the type of onset and coda under investigation. Half of the onsets (36) were simple onsets. The other half were clusters of the following types: 12 –stop + glide–, 12 –stop + liquid–, 12 –fricative + liquid–.[4] Half of the codas were single consonants, whereas the other half were clusters of the following types: 12 –liquid + stop–, 12 –liquid + fricative–, 12 –liquid + nasal–. The set of items is given in Appendix B.

We also designed a set of sentences to be used in a grammaticality judgment task, in part as an additional measure of the subjects' English proficiency. There were 72 pairs of sentences that contained one syntactically licit sentence and one slightly different that violated one of the following syntactic rules and constraints in English: *Do*-support, *that*-trace effects, agreement, case, word order, auxiliary inversion, and adverb placement. For example, a pair that manipulated auxiliary inversion is the following (with target pseudoword):

1. *Everyone likes who Rosa is talking to in the kled.*
2. *Everyone likes who is Rosa talking to in the kled.*

Additional sample items of each of the other types are given in Appendix C.

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Tasks.[5] Subjects performed two tasks. In Task 1, they were instructed to listen to a word (a target pseudoword) and to circle the word that they thought they heard from a set of four or five possibilities. One purpose of this task was to expose them to the target stimuli before they were asked to produce them. The other purpose was to examine how they heard complex onsets and codas (though this will not be reported in any detail here). Subjects heard and responded to 120 items, consisting of the 72 target pseudowords and 48 fillers. The task instructions and examples are given in Appendix D. The items in this task were prerecorded by a female native speaker of midwestern American English so that all subjects were given the same input and the same amount of time to respond. This task took approximately 20 minutes to complete.

In Task 2, subjects listened to sentence pairs and decided which of the two was grammatically correct. There were two reasons for using this type of production task. One was as an additional measure of English proficiency, beyond the information requested in the background questionnaire. We do not wish to imply any correlation between phonological and syntactic proficiency; rather, we simply wanted one measure on which we could equally compare all of our subjects. The second, and perhaps more important, reason is that we did not want subjects to simply repeat sentences because that would allow them to ignore meaning and focus their attention on pronunciation, which may not reflect purely natural speech (see Hancin-Bhatt, 1994a, for further discussion). Requiring subjects to make grammaticality judgments forced them to attend to meaning to decide which of the sentences was correct, while still getting them to produce the target word.

Each of the sentences contained a target pseudoword. Subjects were instructed to repeat the sentence that they thought was grammatically correct, thus ensuring that they would produce the target items. Subjects were also allowed to read a written version of the sentences, because of their lower level of proficiency and the rapidity of the task (see note 5). The subjects' responses were tape-recorded. An example of Task 2 is given in Appendix D. Again, the items in this task were prerecorded by the same native speaker described in Task 1 so that all subjects were given the same input and the same amount of time to respond. This task took approximately 23 minutes.

After performing the two tasks, subjects filled out a background questionnaire on their English language learning experience. The questionnaire is given in Appendix E. The entire testing session took approximately 50 minutes, and subjects were paid $5 for their time.

In this paper, we present the data on their production of complex onsets and codas. Their responses for each target word (on Task 2) were transcribed in narrow phonetic transcriptions from the recordings. Errors were then recorded separately, and three main categories of errors in consonant clusters were apparent: consonant deletion, vowel epenthesis, and cluster deletion (cluster completely substituted with another sound or not produced at all).[6] A second, independent transcriber provided transcriptions of the target items (Task 2) for half of both sets of subjects. Interrater reliability was 90%, and in the cases in which there was disagreement between the transcriptions a third transcriber was consulted. Error identification and classification of

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Table 4. Mean number of onset errors: Onset type and language

	Onset Type		
Language	–stop + glide–	–stop + liquid–	–fricative + liquid–
Spanish	1.9	0.4	0.8
Japanese	1.6	1.6	2.1
Mean total	1.8	1.0	1.5

Table 5. Mean number of coda errors: Coda type and language

	Coda Type		
Language	–liquid + stop–	–liquid + fricative–	–liquid + nasal–
Spanish	1.7	1.6	2.1
Japanese	2.1	2.8	2.7
Mean total	1.9	2.2	2.4

all transcriptions was also done independently by the second transcriber, and interrater reliability for this was 98%. Because the number of cluster deletion errors was insignificant overall, we focus on the consonant deletion and epenthesis errors only.

Results

First, we present the results of analyses of variance (ANOVA) in production errors in onsets, then codas, and finally asymmetries in errors between the two.[7] The 20 subjects produced 12 instances of the target (consonant cluster) onset and coda types, yielding a total of 240 productions for each category. The results are presented as an average number of errors per subject in each category.

Onsets: Error Rates. As can be seen in Table 4, subjects performed differently across the three onset types tested. For –stop + glide– onsets, Spanish speakers erred on average in 1.9 cases, whereas Japanese speakers erred on average in 1.6 cases. There was no significant difference in their performance on these onsets ($p = .3791$). For –stop + liquid– onsets, however, there was a significant difference between the two ($p < .01$): Spanish speakers erred in only 0.4 cases, whereas Japanese speakers erred on average in 1.6 cases. For the –fricative + liquid– types, Spanish erred on average in 0.8 of the cases, whereas Japanese erred on average 2.1 times. This difference, too, was significant ($p < .01$).

Codas: Error Rates. The results for coda errors, summarized in Table 5, were different in that there was no main effect for language. For –liquid + stops–, Spanish speakers erred on average 1.7 times, whereas Japanese speakers erred 2.1 times; the difference was not significant ($p = .5784$). For –liquid + fricative– codas, Spanish

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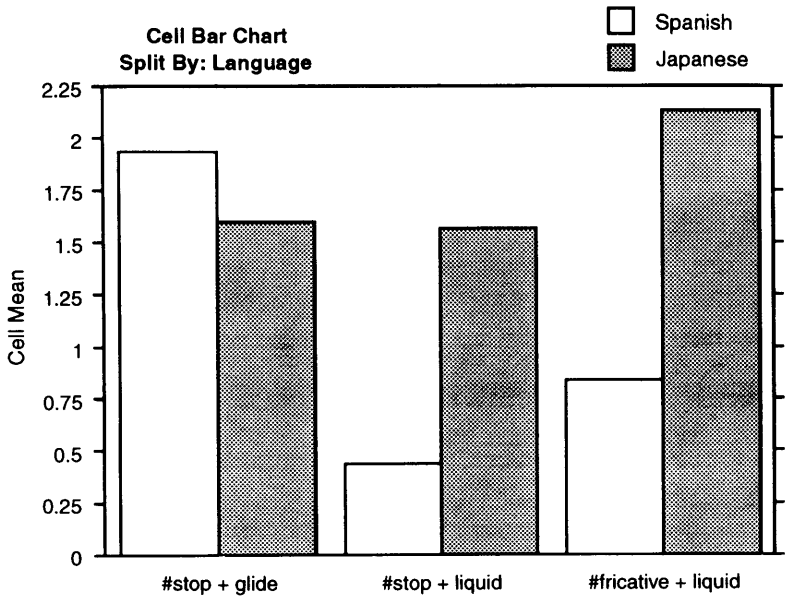


Figure 1. Mean number of onset errors: onset type by language.

speakers erred 1.6 times, whereas Japanese speakers erred 2.8 times, and this difference did not reach significance ($p = .0584$). Finally, for the –liquid + nasal– codas, Spanish speakers erred on average 2.1 times, whereas Japanese speakers erred on average 2.7 times; the difference was not significant.

Discussion of Error Rates

The results from this experiment generally support the hypotheses that were generated based on the MSD model. In Hypothesis 1, we predicted that Spanish speakers would perform better than Japanese speakers on the –stop + liquid– and –fricative + liquid– onsets due to transfer from the first language. The results, represented graphically in Figure 1, support this hypothesis. Although the two language groups had a minimal difference in their performance on –stop + glide– onsets, there was a significant difference in their performance on the other two types, with Spanish speakers exhibiting a much greater ability. Even though the Japanese speakers had more experience learning English, overall they did not perform as well as Spanish speakers on the –stop/fricative + liquid– onsets.

Furthermore, these results also address our second hypothesis, which predicts that there is an inverse relationship between production difficulty and sonority difference: As the sonority difference between the two consonants in the complex onset decreases, the rate of production error increases. This hypothesis is only partially supported by our data. For both language groups, the –fricative + liquid– onset was more difficult than the –stop + liquid– one. However, the results for the

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–stop + glide– onsets are not as predicted. For Spanish speakers, this was the most difficult complex onset type, and this difficulty is most likely due to the positive transfer effects in the other two types of onsets and the lack of those effects in –stop + glide– onsets. Japanese speakers, on the other hand, performed similarly in –stop + glide– and –stop + liquid– types, results that are similar to those found in Broselow and Finer (1991). They found no significant difference in their learners' errors on –py–, –by–, and –pr– onsets, and because there was such a low rate of errors in these types they concluded that learners must have already learned them. Because Japanese does not have complex onsets, including no –stop + glide– onsets, we do not expect any transfer effect in their performance.[8] Our data, like those of Broselow and Finer, suggest that these learners are at a similar stage of acquisition for the two types of clusters.

These results may lend support to Eckman and Iverson's argument that the MSD model does not accurately predict the difficulty of –stop + glide– onsets relative to –stop + liquids–. In their discussion, they show that Clements's sonority distribution principle predicts that –stop + glide– onsets are more marked than –stop + liquids–. In our data, transfer from Spanish facilitates these speakers' production of –stop + liquids– but cannot facilitate the –stop + glides– because these are not possible onsets in Spanish. Again, although –stops + glides– do occur in sequence with each other in Spanish, the glide forms part of the syllable nucleus, not the onset, as discussed earlier. On the other hand, because our Japanese speakers performed similarly on both these types of onsets, we cannot use their production of –stop + glide– onsets as evidence to support Eckman and Iverson's claim about their markedness. In short, our data do not resolve the debate about –stop + glide– onsets, but they do suggest an interaction between language transfer and developmental effects due to markedness: In our Spanish speakers, language transfer overrides developmental effects, which is why –stop + glide– onsets are the most difficult type of the three complex onsets tested.

Our third hypothesis predicted that the MSD model could be extended to complex codas. That is, if sonority difference is inversely related to error rate in onsets, then we should get the same effect in codas. Because neither language group allows complex codas word-finally, we predicted that there would be no significant language effects, which is what we found from the ANOVAs. We then collapsed the average error rates across the two groups and found that, in fact, there is an increase in error rates, as the sonority difference between the two consonants decreases. The results from Table 5 are graphed in Figure 2.

Although there were no significant differences between the two groups performance on each onset type, our analysis suggests a slight interaction between language and category type (see Table 5): Spanish speakers find –liquid + stop– and –liquid + fricative– codas equally difficult, but not as much as –liquid + nasals–, whereas Japanese speakers find –liquid + fricative– and –liquid + nasal– codas equally difficult, but less so than –liquid + stops–. We might explain the Spanish data by appealing to word-internal coda restrictions. Word-internally, Spanish does allow complex codas, basically, –stop + fricative– or –liquid + fricative–, as suggested by the following words: [*abs.trak.to*] "abstract," [*pers.pi.caz*] "perspicacious" (Harris, 1983, p. 14). Our data suggest that overriding the word-final constraint on

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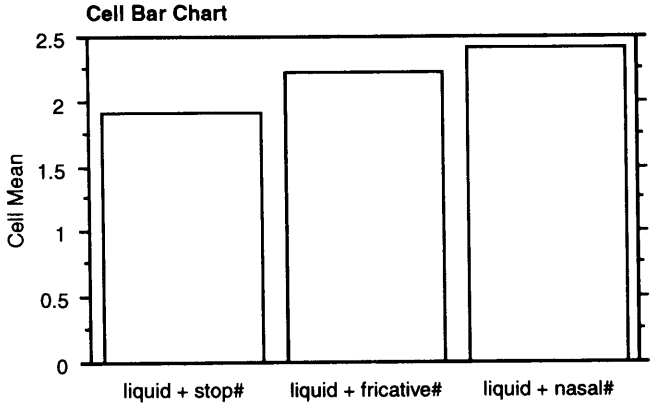


Figure 2. Mean number of coda errors: all learners.

complex codas may be easier for Spanish speakers because these codas are already allowed word-internally. That is not the case, however, for the Japanese speakers. Even though the –liquid + nasal– complex codas should be most difficult for these speakers, they had equal difficulty with the –liquid + fricatives–. Although it is not clear why there is no difference here, we can speculate on the licensing constraints transferred from Japanese. Nasals are licensed in coda position in Japanese, whereas fricatives are not. Thus, perhaps any effect of difficulty due to markedness may be overridden by the slight transfer effect in allowing nasal codas.[9] In other words, we suggest that this language by coda type interaction may be additional evidence of the interaction of language transfer and developmental effects. Further research must be done on codas to test these initial interpretations.

To conclude, the results of our experiment lend support to the MSD model as a predictor of language transfer and sonority-based developmental difficulties in various aspects of L2 syllable structures. However, in its current form, it does not appear to capture subtle effects in our subjects' performance on –stop + glide– onsets, particularly relative to –stop + liquids–. In addition, the MSD model does not capture the result that Spanish speakers find –liquid + stop– and –liquid + fricative– codas equally difficult, whereas Japanese speakers are more likely to find –liquid + fricative– and –liquid + nasal– codas equally difficult. Because neither Japanese nor Spanish have complex codas word-finally, we should see only developmental effects guiding acquisition.

More importantly, during the data analysis, certain patterns in error *types* began to emerge. We cataloged not only how many errors the learners made, but also what type of errors they made. By further exploring our data, beyond the predictions generated from the MSD model, we began to find significant variations in subjects' performance on other rates and types of errors. In particular, we observed differences between onset and coda errors. Furthermore, within the coda deletions, we observed a difference in deletion sites across languages. We explore more carefully these additional patterns in the next section.

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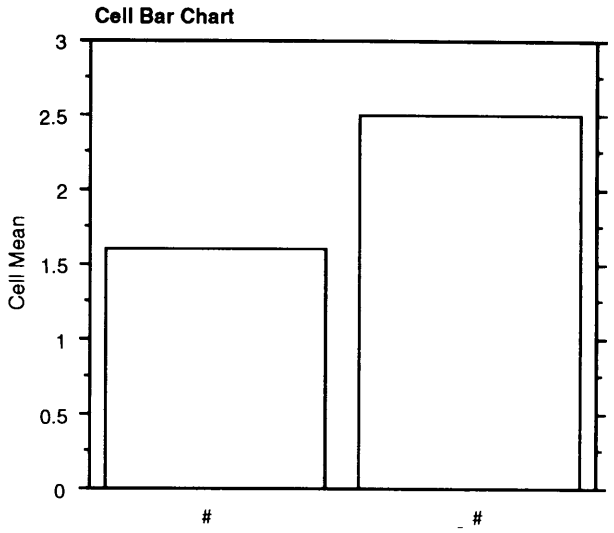


Figure 3. Mean number of onset and coda errors: all learners.

Additional Analyses: Results and Discussion of Error Types

Although the MSD model makes no claims about error rates between onsets and codas, nor does it make predictions about error types, we further analyzed our data to examine whether any of the emerging patterns we observed on error rate and type asymmetries were significant. If significant, they could potentially add to our current understanding of the interaction between language transfer and developmental effects in L2 syllable structure acquisition. ANOVAs were performed to check for significance.

Onset and Coda Asymmetries: Error Rates and Types. Our subjects had a lower rate of errors for onsets at an average of 1.6 errors per onset type than they had for codas at an average of 2.5 errors per type. These figures are graphed in Figure 3. There was no significant difference between the two language groups. These data suggest that word-initial contexts are easier for our subjects than word-final ones. That this difference exists is not surprising if we look at syllable structures cross-linguistically. Syllables prefer to have onsets rather than codas, a generalization that follows from the onset maximization principle. In addition, in any given language, the inventory of phonemes that can be codas is a subset of the inventory that can be onsets (for recent discussions of this issue, see Goldsmith, 1990; Prince & Smolensky, 1993). It can be said, then, that onsets are favored over codas cross-linguistically, which may be why ESL speakers are less likely to err in onsets than in codas. Because the MSD model does not make any predictions about error rates between onsets and codas, we would need another theoretical mechanism to capture this robust generalization in order to describe more fully L2 syllable structures.

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Table 6. Mean number of errors: Error type by cluster location

	Cluster Location	
Error Type	Word-Initial	Word-Final
Epenthesis	2.0	0.1
Deletion	1.2	4.9

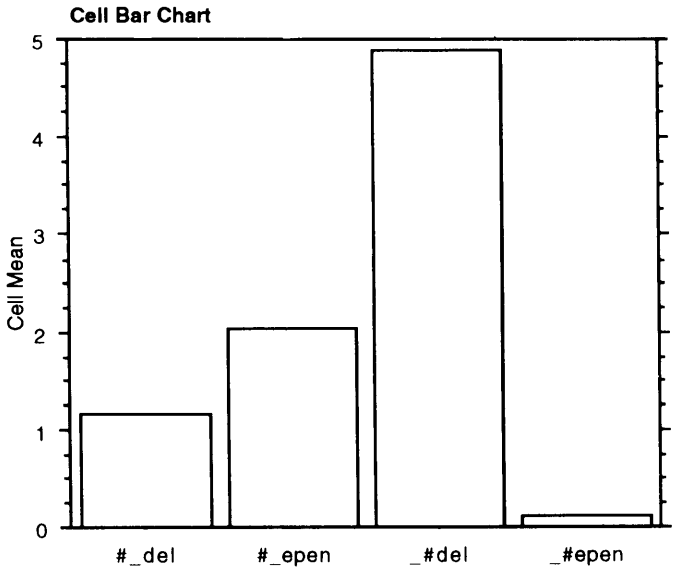


Figure 4. Mean number of deletion and epenthesis errors: all learners.

A comparison of the error types in complex onsets versus codas suggests another asymmetry: Epenthesis is more likely to occur word-initially,[10] whereas deletion is more likely to occur word-finally. That is, depending on location site, illicit syllable structures are repaired using different strategies. As shown in Table 6, our subjects made epenthesis errors in 2.0 cases word-initially, whereas they made 0.1 epenthesis errors word-finally. However, subjects made deletion errors word-initially in 1.2 cases, whereas word-finally, that number increased to 4.9 cases. There was generally no effect for language in these results, except for word-final deletions: Spanish speakers had a mean of 4.13 errors, whereas Japanese speakers had a mean of 5.63 ($p = .0215$). However, we will not explore this particular language effect here, leaving it for future analyses. This asymmetry is graphed in Figure 4.

That learners are more likely to epenthesize vowels syllable-initially and delete consonants syllable-finally may be associated with the effect that they are also less likely to err on onsets than on codas. Both cases suggest that the onset is a privileged

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Table 7. Mean number of deletion errors: Language by deletion site

	CC# → CØ#	CC# → ØC#
Spanish	2.7	1.3
Japanese	1.0	4.3

position in which sounds are more likely to be maintained in L2 phonology acquisition as opposed to the coda position. In related work on Cantonese loanword phonology, Silverman (1992) discussed onset and coda asymmetries in repair strategies. He proposes a dual-level model of (loanword) processing that consists of a *perceptual level of representation* and an *operative level of representation.* Silverman claimed that one reason that nonnative constructions undergo repairs is due to perceptual salience. If segments in the input are perceived as syllabic, then they receive a syllable node, which forces epenthesis if the perceived segment is a consonant (Silverman, 1992, p. 320). Silverman's data indicated that –stop + liquid– (sonorant) onsets are more likely to undergo epenthesis, whereas –sonorant + stop– codas are more likely to undergo deletion (of the stop). He attributed this asymmetry to phonetic salience to the Cantonese ear and concluded that the phonetic salience of segmental input is conditioned by the context in which it occurred. Salience of a segment is reduced when it occurs in an impoverished context (based on language-specific phonotactics) (Silverman, 1992, p. 325). Thus, because obstruents do not occur in coda clusters in at least some dialects of Cantonese, they are difficult to discern in nonnative input, which is why they are likely to be deleted (see also Flege & Wang, 1989).

If word-initial position is the more salient position, then both consonants are likely to be perceived in the input, which would result in epenthesis errors to repair illicit structures. If word-final is a less salient position with greater restrictions on what can occur there, then it is possible that one of the consonants is not perceived in the input, resulting in deletion strategies.[11] Before we develop this further, we consider one more example of asymmetrical behavior in our subjects' production of complex codas.

Coda Deletion Errors: Language by Deletion Site. One final example of an asymmetry that we found is language-dependent. The coda deletion error occurs frequently across all subjects as a repair strategy for difficult, complex structures. Importantly, however, the subjects differ in terms of the consonant that they delete: Spanish speakers are significantly more likely to delete the final consonant ($p <$ .001), thus leaving the liquid as a simple coda, whereas the Japanese speakers are significantly more likely to delete the nonfinal consonant ($p < .0001$), the liquid, thus leaving either a stop, fricative, or nasal. These results are shown in Table 7. The table gives the average number of deletion errors in the final consonant (CC# → CØ#) as compared to the nonfinal consonant (CC# → ØC#) for both sets of speakers. The

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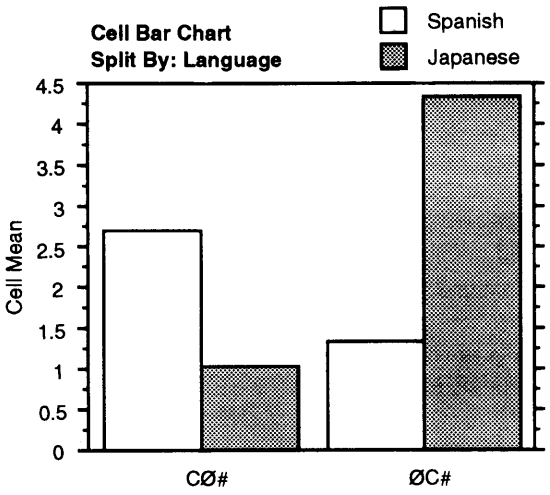


Figure 5. Mean number of deletion errors: language by deletion site.

differences between these two languages are highly significant. This interaction can be seen more clearly in Figure 5.

The site of consonant deletion (either liquid or obstruent), then, depends on the first language. In Spanish, word-final codas are frequently the sonorants /l/, /n/, and /r/. Word-final codas can also be the coronals /s/ and /ð/. Our items testing complex codas consisted of a –liquid + obstruent– or –liquid + nasal–. By deleting the final consonants, these speakers are showing a preference for maintaining the sonorant (liquid) in coda position. In Japanese, however, the only allowed word-final coda is the nasal, which would explain why our Japanese subjects were more likely to retain the nasal and delete the liquid in complex codas. If Silverman's (1992) proposal on perceptual saliency is right, then perhaps in –liquid + obstruent– codas the obstruent is the more salient of the two for Japanese speakers, thus the more likely to be maintained in a deletion strategy.[12] Further investigation of this initial hypothesis is required.

To conclude this section, we summarize the important finds of this study thus far as follows:

1. *Onsets.* The MSD model generally predicts accuracy (or error) rates for these ESL learners, particularly the relationship between –stops + liquids– and –fricatives + liquids–, the former being more difficult than the latter. However, it incorrectly predicts that Spanish speakers should produce –stop + glides– more easily than they did. In its current form, then, the MSD model does not capture language-specific irregularities that also affect L2 phonology.
2. *Codas.* The MSD model extends to coda clusters, correctly predicting that L2 learners will have increasing difficulty producing complex codas as the difference in sonority between the two consonants decreases.

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3. *Error types.* The MSD model does not predict, however, the clear pattern in our data regarding learners' error types. We find significant evidence for two types of errors. First, consonant deletion in codas is language-dependent: Spanish speakers are more likely to delete the second consonant, whereas Japanese speakers are more likely to delete or modify the first. Second, L2 learners are more likely to use vowel epenthesis to resolve difficult onsets but consonant deletion to resolve difficult codas.

Thus, the generalized constraints on sonority sequencing provided by the MSD model do make significant predictions on the facility with which learners will acquire complex syllable structure. However, they only account for a part of the effects we observed in our experiment. Exploring the data beyond the accuracy (or error) rates to observe error types has provided evidence that the effect of cross-language transfer is significantly more robust than the parameter-based MSD model captures. Therefore, we are compelled to consider a refinement of or an elaboration on the MSD model as a linguistic-theoretic framework for explaining the subtle interactions of cross-language transfer and (UG-based) developmental effects in syllable structure acquisition.

OPTIMALITY THEORY AND L2 SYLLABLE STRUCTURE

We propose that a more comprehensive account of L2 syllable structures is available by adopting a different grammatical framework than previously proposed, one that not only indicates which structures are illicit for a given language but that also indicates how and why illicit structures surface the way they do, conforming to the grammar available to the speaker. The framework we explore is optimality theory (OT) as developed in Prince and Smolensky (1993). We will show that an OT analysis presents a more defined interpretation of the interaction of language transfer and developmental effects in syllable structure acquisition, allowing us to account not only for learners' success rate but also for their error types.

We begin this section with a brief introduction to OT to highlight basic assumptions it makes about the grammar. We then discuss fundamentals of syllable structure theory within OT. We present analyses of Spanish and Japanese syllables to show how OT accounts for cross-linguistic variation and discuss how the Spanish and Japanese analyses can be used to understand transfer and developmental effects observed in our experiment. Finally, we discuss how OT builds on the insights provided in previous linguistic-theoretic analyses to cover a broader range of effects.

Optimality Theory: A Brief Introduction[13]

Unlike rule-based approaches to the grammar, OT assumes the existence of a universal set of constraints on the well-formedness of linguistic structures. The basic operation of the OT grammar is represented in Figure 6 and works as follows. An input (underlying form) enters the system and a set of candidate structural descriptions of the input is generated via a function known as the Generator, or GEN. These structural descriptions are then evaluated according to how well they conform to the set

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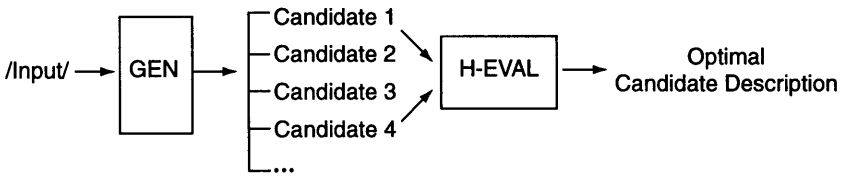


Figure 6. Basic structure of the OT grammar (adapted from Prince & Smolensky, 1993, p. 4).

of universal constraints, and this is done via the Harmony Evaluator, or H-EVAL. The output of the grammar is the most well-formed, or optimal, description. These two functions in particular distinguish OT from previous approaches to the grammar.

The constraints are ranked in the H-EVAL according to how strongly they hold in a particular grammar. They are violable and potentially conflicting, and a violation in a higher ranked constraint overrides one in a lower ranked constraint. If there is no conflict between two constraints, they are not ranked relative to each other.[14] The higher ranked the constraint is in a grammar, the more serious its violation is. The optimal description is the one with either no or the least serious constraint violations, based on the ranking.

Tableaux, like the one in (1), show the results of H-EVAL on the candidate structural descriptions of a given input.

(1) Sample tableau

/INPUT/	Constraint 1	Constraint 2	Constraint 3
Description A	*!	*	
Description B		*	*!
⇒ Description C			*

The solid line between Constraints 1 and 2 indicates a dominance relationship, and this is also noted as

Constraint 1 ≫ Constraint 2

The dotted line between Constraints 2 and 3 indicates a lack of dominance, thus these two constraints are not ranked relative to each other. Asterisks represent violations: Description A above violates Constraints 1 and 2. An *! indicates a fatal violation, which disqualifies the candidate from being optimal in this particular evaluation. Because Description A violates the higher ranking Constraint 1, it is immediately rejected as the optimal candidate. Description B violates two constraints, and, although they are unranked relative to each other, the second violation disqualifies this output relative to Description C, because the latter has only one violation. In tableau (1), then, Description C is the optimal candidate, and this is

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represented here with the arrow, ⇒. Shaded areas indicate that further evaluations are unnecessary because of the candidate's disqualification as optimal.

In OT, Universal Grammar presents a set of structural descriptions for each input, based on a set of (universal) conflicting constraints that hold in all languages. Linguistic variation arises from the fact that languages rank these constraints differently. For example, let us assume three constraints can be ranked relative to each other in one of three ways:

1. Constraint 1 ≫ Constraint 2 ≫ Constraint 3
2. Constraint 2 ≫ Constraint 1 ≫ Constraint 3
3. Constraint 3 ≫ Constraint 2 ≫ Constraint 1

These ranking relationships yield three different optimal forms for the same input and thus describe three different grammars. In OT, *knowledge* of language consists of the universal set of structural descriptions, the universal set of constraints on these descriptions, and a language-particular ranking of the constraints (Smolensky, 1994). Markedness relations are also encoded in constraint rankings: Certain constraints are inviolable (i.e., are ranked highest) cross-linguistically, other constraints have a strong tendency to be inviolable across languages, whereas still others exhibit greater variability. The variability depends on the relative ranking of a constraint within a language. In essence, grammar_x computes the optimal form (fewest constraint violations) of the candidate structural descriptions (defined by GEN) for an input according to the constraint ranking of language_x.

In OT, *acquisition* is a problem of learning the constraint rankings that govern the input of language_x. The assumption is that constraint rankings are stable at a given point, but when new (L2) input that does not conform to the starting-point rankings enters the grammar, an error message of sorts is sent to the H-EVAL, potentially effecting a change in the rankings for that particular input. L2 acquisition in OT is reduced to learning another configuration of constraint rankings, based on L2 input. (For a discussion of general language acquisition, see Tesar and Smolensky, 1993.) Itô and Mester's (1994, 1995) proposal on nonnative words argues that a particular phonological grammar may contain various, minor rerankings, depending on the source of the words borrowed into the lexicon. They claimed that lexicons of natural languages are, in fact, stratified, yielding a core-periphery organization, with native vocabulary forming the core and gradually moving outward to established loanwords, then to borrowed foreign vocabulary, and finally to unassimilated foreign vocabulary. Itô and Mester argued that for each stratum, a slightly different, yet predictable ranking holds. In this way, speakers may have predictably different rankings for different sets of words.

Syllable Structure Constraints in OT

To illustrate how OT provides insight into syllable structures in L2 phonology, we first discuss the relevant constraints that yield CV templatic structure and licensing restrictions. The basic syllable structure constraints are the following (Prince & Smolensky, 1993, p. 88):

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ONS:	All syllables must have onsets.
-COD:	Syllables must not have codas.
NUC:	Syllables must have nuclei.
*COMPLEX:	No more than one C or V may associate to any syllable position node.
Associational Constraints:	There is a family of constraints that indicates the harmony of segments in specific syllable position based on sonority prominence. For example, *M/V: No vowels may appear in syllable margins (onset or coda). *P/C: No consonants may appear in syllable peak (nucleus).
PARSE:	Underlying (input) segments must be parsed into syllable structure.
FILL:	Syllable positions are filled with segmental material. ($FILL^{ons}$; $FILL^{nuc}$)

The constraints ONS, -COD, PARSE, and FILL can be ranked in any order to yield language-specific structure.

In OT, the onsets are defined by the rankings of constraints {ONS, $FILL^{ons}$, PARSE}, whereas codas are defined mainly by the rankings of {-COD, $FILL^{nuc}$, PARSE} (Prince & Smolensky, 1993, pp. 92–93). The only constraint that affects the two syllable positions is PARSE. That different constraints govern onsets and codas allows us to show how their segmental distributions differ from each other.

It is beyond the scope of this paper to argue for each of the preceding constraints, but the interested reader can follow these justifications in Prince and Smolensky (1993). A simple explanation of how these constraints work is given in (2). The sample analyses (candidate structural descriptions) of the input /CVCV/ are described, and the constraint violations given. All of these analyses satisfy NUC and *COMPLEX. Angle brackets (< >) indicate an unparsed (ignored, thus deleted upon output) segment, whereas a diamond (◊) indicates an unfilled (requires segment upon output) segment. A period between the C or V indicates a syllable margin. A lowercase sigma (σ) denotes a syllable.

(2) Analyses of /CVCV/

Analysis	Interpretation	Violation	Remarks
a. CV.CV	2 CV syllables		satisfies FILL, PARSE, ONS, -COD
b. <C>V.CV	1st σ has unparsed C	*ONS (σ1), *PARSE	satisfies ONS (σ2), FILL, -COD, PARSE (σ2)
c. CVC.V	1st σ has coda; 2nd σ is onsetless	*-COD (σ1) *ONS (σ2)	satisfies FILL, PARSE, ONS (σ1), -COD (σ2)

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d. CVC.◊ V	1st σ has coda; 2nd σ has empty onset	*-COD (σ1) *FILL (σ2)	satisfies PARSE, ONS, -CODA (σ2)

The candidate description which analyzes /CVCV/ as CV.CV is universally more harmonic than the others because there are no violations of the constraints under consideration. The other three candidates ((2)b–d) violate two constraints each, so until we know the relative rankings of the constraints we cannot determine which would be the most optimal among them. Thus, if we were interested in the second most harmonic candidate in this analysis, it could only be derived from a language-specific constraint ranking.

To further illustrate how these ranked constraints compute optimal forms of a given input based on language-specific rankings, in the next section we present analyses of complex onsets and codas in Japanese and Spanish. We show that the constraints defined above yield different harmonic outputs cross-linguistically, depending on language-specific dominance hierarchies.

Spanish and Japanese Syllable Structure in OT

We begin our analyses of Spanish and Japanese with a comparison of the constraint rankings for onsets in each language. We then discuss the relevant constraints and rankings for codas. These analyses are important to demonstrate that (a) cross-linguistic variation is a result of different syllable constraint rankings and (b) these native rankings affect ESL syllable construction, forming the source of learner error types.

Onsets. *Spanish.* In Spanish, onsets are optional, regardless of their location in the word (Colina, 1995). Onsetless syllables are licensed by the interaction of three constraints: ONS, PARSE, and FILL (Prince & Smolensky, 1993). Specifically, the constraint hierarchy is such that it is worse to violate either PARSE or FILL than to violate ONS, thus PARSE, FILL ≫ ONS. The tableau in (3) shows that the optimal analysis of this input is [a.sa] because the violation of ONSET is the least serious violation, due to its ranking.

(3) Analyses of /asa/

/asa/	PARSE	FILL	ONS
<a>sa	*!		
◊a.sa		*!	
⇒ a.sa			*

A violation in PARSE for this VCV input, which would have resulted in a deleted initial V, is simply not attested in Spanish, whereas a violation in FILL would have resulted in an epenthesized segment, which also is unattested in Spanish.

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As indicated earlier, Spanish also allows complex onsets. In OT terms, this means that violations in *COMPLEX are less serious than those in FILL and PARSE. Even when the cluster is in nonword-initial position, we see that Spanish still prefers to make complex onsets when possible (Colina, 1995), requiring that -COD dominate *COMPLEX. Thus, we obtain the following dominance hierarchy: PARSE, FILL, -COD ≫ *COMPLEX^{ons}.[15] This is demonstrated in (4)[16]:

(4) Analyses of /abla/

/abla/	PARSE	FILL	-COD	*COMPLEX
a <b>la	*!			
a.b◊.la		*!		
ab.la			*!	
⇒ a.bla				*

The optimal analysis in the preceding tableau is [a.bla] because it incurs the least serious violation. Of course, the caveat to the preceding description is that Spanish prefers to make complex onsets when possible, which literally translates into when the segment sequences are licensed as possible onsets. This takes us into another set of constraints formalized in OT, namely, the set that refers to the compatibility (or harmony) of segments in specific syllable positions.

Segment harmony in specific syllable positions in OT is based on sonority relationships (Prince & Smolensky, 1993, chap. 8). First, syllable positions are defined in terms of (sonority) peaks and margins. As has often been claimed, syllables exhibit rising then falling sonority, and the peak of the sonority is the nucleus of the syllable. Thus, the margins are onsets and codas. OT constrains associational harmonies between segments and syllable positions as follows: The more sonorous a segment, the more harmonic it is as a peak, whereas the less sonorous it is, the more harmonic it is as a margin (Prince & Smolensky, 1993, p. 129). This is formally represented in an encapsulated form as *M/V, which is a constraint against vowels in margin position, and *P/C, which is a general constraint against consonants in the peak. The associational harmonies for Spanish margins, then, are such that vowels in the margin are more serious violations than consonants, and the more sonorous the vowel or consonant, the greater the violation relative to other vowels or consonants. Colina (1995, p. 53) gives the constraint hierarchies for Spanish (based on the sonority scales derived for Spanish in Harris [1989]).

(5a) Spanish margins
*M/a ≫ *M/e, o ≫ *M/i, u ≫ *M/liquids ≫ *M/nasals ≫ *M/obstruents

(5b) Spanish peaks
*P/obstruents ≫ *P/nasals ≫ *P/liquids ≫ *M/i, u ≫ *M/e, o ≫ *M/a

Limits on which segments can occur as margins/peaks are also set via the construct of parameter value (π). For example, π_{ons} refers to the most sonorous element

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that can occur in onset position. All segments that are less sonorous than π_{ons} are also possible onsets of the language (Prince & Smolensky, 1993, chap. 8). Colina (1995, p. 54) proposes the following parameter values for Spanish:

a. Onset parameter π_{ons} = /l, r/
b. Nucleus parameter π_{nuc} = /i, u/

To account for the fact that only obstruents and liquids can combine to form onsets (i.e., no *M/obstruent + nasal), Colina (1995, p. 63) proposes the Onset Sonority Constraint (O SON), which she defines as follows:

> 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.[17]

This constraint disallows /arko/ from being parsed as [a.rko], even though the alternative [ar.ko] violates -CODA. This means that O SON dominates -COD: It is less harmonic to have an illicit onset than to violate the no coda constraint. This is represented in the tableau in (6).

(6) Analyses of /arko/

/arko/	O SON	-CODA
a.rko	*!	
⇒ ar.ko		*

As Colina (1995) argues, PARSE is not unranked relative to FILL because Spanish does exhibit epenthesis word initially. Candidate analyses that violate FILL are less serious than those that violate PARSE. Analyses that violate PARSE are less serious than those that violate O SON. Thus, the hierarchy O SON ≫ PARSE ≫ FILL, which is represented in (7):

(7) Analyses of /spa/

/spa/	O SON	PARSE	FILL
spa	*!		
<s>pa		*!	
⇒ ◊s.pa			*

The final ranking for these constraints in Spanish, then, is the following:

(8) Constraint Ranking for Spanish Onsets (Colina, 1995, p. 64)
O SON ≫ PARSE ≫ -COD ≫ *COMPLEX^{ons}

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We now move on to a discussion of Japanese onsets to show how the reranking of these constraints yields the different onset possibilities that are allowed in Japanese. This discussion is shorter than that of the Spanish one because the range of licensed onsets in Japanese is more limited and because the proposed ranking is a preliminary analysis that needs to be argued more carefully in the appropriate forum. For purposes of this paper, we simply wish to establish a hypothesized ranking that can be tested against their accuracy (or error) patterns in ESL.

Japanese. Japanese, like Spanish, also allows onsetless syllables word-initially and -internally, which suggests the same ranking of the initial constraints as Spanish: PARSE, FILL ≫ ONS. As shown in the tableau in (3) above, this ranking ensures that the optimal candidate of an input form such as /asa/ is [a.sa], and not (a) *[<a>sa], nor (b) *[◊ a.sa]. Japanese does not delete initial onsetless syllables, nor does it epenthesize consonants to fulfill the ONSET constraint. In addition, as discussed earlier in the paper, Japanese does not allow complex onsets. In the absence of evidence from native Japanese vocabulary of analyzed complex onsets, English loanwords in Japanese provide an indication of the relative ranking of *COMPLEX.[18] As the following data indicate, Japanese tends to epenthesize a vowel between the two consonants, rather than delete one of them.

	English	Japanese
"school"	/skul/	/suku:l/
"crane"	/kren/	/kulen/

These data suggest two sets of rankings. First, they indicate that parsing the consonant cluster as a complex onset is a greater violation than parsing an extra syllable node via FILL. Second, because there is vowel epenthesis, rather than consonant deletion for the illicit onset, a violation in PARSE is more serious than one in FILL. There is, as yet, no evidence to determine a ranking between *COMPLEX and PARSE. Thus, we get the following constraint hierarchy: *COMPLEX, PARSE ≫ FILL, represented in the tableau in (9).

(9) Analyses of /kre/

/kre/	*COMPLEX	PARSE	FILL
kre	*!		
<k>re		*!	
⇒ k◊.re			*

Notice that the site of the epenthetic vowel in Japanese is between the two consonants, whereas for Spanish, the site was before the cluster. Japanese, then, follows the universal tendency to avoid violations of ONS and -COD, thus parsing syllables with onsets (CV) as more harmonic than those without (VC). In addition, because Japanese does not allow complex onsets, there is no need to posit a ranking

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for O SON at this point in time. Thus, we posit the following constraint ranking for Japanese:

(10) *COMPLEX, PARSE ≫ FILL ≫ ONS

A comparison of the Japanese and Spanish rankings shows that variation in the types of syllable structures they license are a result of different constraint rankings. O SON is crucially ranked in Spanish, but unranked relative to the syllable structure constraints in native Japanese vocabulary. *COMPLEX is also more prominent in Japanese than in Spanish. Next, we consider how their codas also differ as a result of rerankings.

Codas. As stated earlier, it is well known that languages have greater restrictions on codas than on onsets. What can appear as a coda is generally a subset of what can appear in the onset (Prince & Smolensky, 1993, p. 160). OT allows a principled explanation of these onset and coda asymmetries in part through the sets of constraints associated with each syllable position and in part through their domination relationships. Just as with onsets, the variation in well-formed coda structures between Spanish and Japanese can be represented through constraint rerankings.

Japanese. Although Japanese tends to be a coda-averse language, it does allow nasal /n/ to close a syllable (Vance, 1987) word-finally, in addition to part of geminate and homorganic clusters word-internally. This is shown in (11)[19]:

(11) Japanese codas

1.	/san/	[san]	honorific particle
2.	/kitte/	[kit.te]	"stamp"
3.	/yom + te/	[yon.de]	"reading"
4.	/tor + te/	[tot.te]	"taking"

For purposes of this study, we consider word-final codas only. In OT, the preceding generalizations on Japanese codas are analyzed as violations in the -COD constraint, which are less serious than violations of PARSE or FILL. Thus, we obtain the following dominance hierarchy and tableau: PARSE, FILL > > -COD.

(12) Analyses of /san/

/san/	FILL	PARSE	-COD
sa.n◊	*!		
sa<n>		*!	
⇒ san			*

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Because only nasals close syllables, the parameter value for Japanese codas is set low:

Japanese Coda Parameter π_{cod} = nasals

To prevent the Japanese liquid from occurring in codas, we need to assume that it is less sonorant than the Japanese nasal, although we do not have evidence for this at the current time. All the obstruents are unarguably less sonorant, which should potentially make them codas. However, Japanese codas are restricted only to nasals. This restriction can be captured via the associational harmony rankings, such that it is a greater violation to parse nonnasals in the coda than nasals, and it is worse to parse nonnasal consonants as a coda than to have an unfilled peak, thus the hierarchy in (13).

(13) Japanese coda constraint on associational harmony
$*M^{cod}/C_{nonnasal} \gg *M^{cod}/n, *P/\diamond$

Additionally, we can establish a relative relationship between PARSE and FILL by looking at loanwords (from Itô & Mester, 1995). Borrowings that have nonnasal codas are produced with an epenthetic vowel, as suggested by the data in (14):

(14) English loanwords in Japanese

1.	/ǰiguzagu/	"zigzag"
2.	/fu:do/	"food"
3.	/zippu ko:do/	"zip code"
4.	/disuku/	"disc"

In Japanese borrowings, then, it is a less serious violation to overparse, by adding a segment, than to underparse, or by deleting one. Thus, we obtain the following ranking: PARSE ≫ FILL. Furthermore, Japanese native vocabulary predictably does not exhibit any complex codas, and loanwords with complex codas undergo double epenthesis (e.g., 14.4). The ranking for $*COMPLEX^{cod}$, then, must be at least as high as PARSE. For the moment, we give no ranking relationship between these two constraints. This gives us the entire set of rankings (for our purposes) for Japanese codas, as shown in (15).

(15) Constraint ranking for Japanese codas
$*COMPLEX^{cod}$, PARSE ≫ FILL ≫ -COD

Finally, there is a further constraint on coda licensing: In the case that nonnasal consonants occur in codas in Japanese, it is worse to violate PARSE than to insert a vowel, thus, PARSE ≫ *P/◇.

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The tableau in (16) shows the optimal parses, based on rankings from the above discussion, for CVC input.

(16) Analyses of /zip/ and /zin/

/zip/	*M^{cod}/$C_{nonnasal}$	PARSE	FILL	*M^{cod}/n, *P/◊
zip	*!			
zi<p>		*!		
⇒ zi.p◊			*	*
/zin/				
⇒ zin				*
zi.n◊			*!	*
zi<n >		*!		

Notice that the most harmonic output for /zip/ is "zippu" (Example 14.3), which, in addition to vowel epenthesis, has undergone consonant gemination. The relevant constraints and rankings that yield the geminate as more harmonic than the single /p/ are not discussed here because they are not directly relevant to the focus here on vowel epenthesis. Thus, the geminate is not represented here in the candidate outputs.

Spanish. Spanish allows a greater range of codas than Japanese: Simple coronal codas are licensed word-finally, whereas complex codas occur word-internally. For this paper, we focus on the word-final codas, because that is most relevant for our data from these speakers' ESL. For a more extended discussion, sample analyses, and justification of constraint rankings, see Colina (1995, esp. chap. 3).

Here we give the constraint rankings for Spanish codas as argued in Colina (1995). First, because codas are allowed in Spanish, -COD is not a serious violation. Along with the basic *$COMPLEX^{cod}$ and PARSE and FILL, she argued for a special constraint, which does not refer to sonority, on codas. The Coda Condition, or CODA COND, restricts codas to only segments with a coronal point of articulation (pp. 63, 183). The basic ranking she argued for is as follows.

(17) Constraint rankings for Spanish codas
CODA COND, *$COMPLEX^{cod}$ ≫ PARSE ≫ FILL

This ranking indicates that Spanish generally does not allow complex codas (word-finally) and that it prefers to have epenthesis over deletion in codas that violate the coda condition (see Harris, 1986). In fact, we can observe this in the Spanish borrowings from English given in (18)[20]:

(18) English loanwords in Spanish and noncoronal coda resolution

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English	Spanish
"garage"	/garáči/
"spring"	/espríngе/
"truck"	/tróka/
"switch"	/suíče/

We now have rankings among the basic syllable constraints posited for Japanese and Spanish onsets and codas. As already shown, cross-linguistic variation in syllable structures in OT is a result of (universal) constraint rerankings. We may now begin to explore the impact that this has for explaining syllable structures in Spanish and Japanese speakers' ESL. Critically, we want to explore to what extent this analysis can explain transfer and developmental effects in L2 syllables.

An OT Analysis of ESL Syllable Structure

We begin this section with an abbreviated presentation of the summarized findings from our experimental study on L2 syllables. If an OT analysis is to be considered a viable alternative to other grammatical frameworks, it must account for a greater range of effects than other frameworks. In this section, we discuss how it does so.

1. *Onsets.* The MSD model generally predicts error rates for Spanish and Japanese ESL learners, except for Spanish speakers' production of –stop + glides–.
2. *Coda.* The MSD model correctly predicts difficulties in learners' production of complex codas.
3. *Error types.* The MSD model does not predict patterns in learners' error types, particularly with respect to coda deletions and the onset-epenthesis, coda-deletion asymmetry.

It is important to note that we are making an assumption here about the relationship between the L1 and developing L2 grammar. In line with a parameter resetting framework, we assume that learners begin L2 acquisition by instantiating the grammatical settings of their L1 onto an L2 grammar (for arguments in L2 phonology, see Archibald, 1993; Broselow & Finer, 1991; Broselow & Park, 1995; for arguments in L2 syntax, see Schwartz & Sprouse, 1996). Gradually, as a result of exposure to L2 input, the developing grammar gets reconfigured to reflect the parameter values of the L2. This idea has also been developed in computationally oriented discussions of L2 acquisition (e.g., Gasser, 1990; Hancin-Bhatt & Govindjee, to appear; MacWhinney, 1987, 1989).

This insight is easily captured within an OT analysis. Because all constraints are universal, the learner does not have to learn new constraints for the L2. Rather, what the learner has to do is learn the prominence of these constraints relative to each other in the new grammar. That is, in initial L2 learning the constraint ranking from the L1 is instantiated onto the L2 grammar, thus L2 input is parsed within an H-EVAL that is L1-based. Although the rankings are reconfigured over time to more closely reflect the L2, we can see vestiges of the L1 rankings perhaps due to their resistance to being reranked.

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ESL Syllable Structure: Onsets. *Spanish.* OT allows us to account for the rates of error in the complex ESL onsets of our Spanish speakers, particularly when we appeal to the native Spanish constraint ranking for onsets, which we give again here:

O SON ≫ PARSE ≫ -COD ≫ *COMPLEX^{ons}.

The first experimental effect we can explain is that –stop + liquid– clusters were easier than –fricative + liquid– ones. The constraint on complex onsets is ranked low, indicating that it is not a serious violation, thus allowing Spanish to have complex onsets before over- or underparsing segments. That clusters with a greater sonority difference are easier (i.e., more harmonic) is captured via Colina's constraint O SON, which requires a maximum sonority distance in onsets. Fricatives, which are of higher sonority than stops, combined with liquids, are less harmonic according to this constraint, because the sonority distance between the two consonants is smaller; thus, they are more difficult for our learners relative to –stop + liquids–.

The second important effect we must explain is these learners' performance on –stop + glide– onsets, which was the most difficult cluster for them. According to the MSD model, Spanish speakers should have done just as well or better on these as they did on –stop + liquids–. However, Spanish onsets do not conform to the sonority sequencing generalizations generated by the MSD model because it does not have –C + glide– onsets. In Spanish, the glide forms part of the nucleus; they are probably derived from vowels (e.g., Carreira, 1990). This can be interpreted within OT via the constraints on associational harmonies. Literally, it is more harmonic to parse a glide as a syllable peak than as a margin: *M/glide ≫ *P/glide. Because our learners saw the onglides in their orthographic forms of /y, w/ and not as /i, u/, as they do in Spanish when it forms part of the nucleus, it is likely that they tried to parse the glide as part of the onset (or syllable margin), which would be more difficult for them than if they had tried parsing the glide with the nucleus. In fact, parsing the glide in the nucleus in some of the pseudowords (e.g., *kwelf, twirt*) would have violated the three-segment-or-less condition on Spanish rimes (Harris, 1983, p. 10). Thus, rather than delete the glide or violate the rime condition, learners preferred to parse it as a simple onset. Clearly, this is an initial interpretation of the effect, and a more focused study on these complex onsets would need to be done to further support the analysis.

Japanese. We now turn to an analysis of Japanese onsets, restating the relevant native constraint rankings: *COMPLEX, PARSE ≫ FILL ≫ ONS.

The constraint on complex segments is ranked high in Japanese, so any violation of this is a serious one, which is likely why our Japanese learners had higher error rates than our Spanish learners. Thus, there was no facilitative effect for any of the clusters as we saw in Spanish: Japanese onset error patterns are purely a result of developmental constraints. However, our learners performed similarly on –stop + glide– and –stop + liquid– clusters; they found these equally easy (or difficult). Here, we note that Colina's proposed O SON constraint captures the same generalization on sonority sequencing in consonant clusters as the MSD model: Languages select a certain sonority distance that must be maintained between the consonants in combination. In the absence of complex segments, as in the case of Japanese, UG takes over to find clusters with greater sonority distance as more harmonic than

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those with less distance. In OT, then, like in the MSD model, –stop + glide– onsets should theoretically be easier than the –stop + liquids– because of the former's greater sonority distance, unless, of course, there is a dominant constraint against glides in onsets.

Like Broselow and Finer (1991), we cannot explain this performance other than to assume that our learners are advanced enough in the learning experience that they have overcome, to some extent, the difficulty with the –stop + liquid– onsets so that they appear to be just as easy (or difficult) as the –stop + glides–. In OT, we could interpret this as a constraint on onset sonority that evaluates the well-formedness of –stop + glides– the same as that of –stop + liquids–. The prediction is, however, that the learners started out with a difference between the two, but that with exposure to the L2 the constraints have reranked, thus yielding the preceding stated effect on well-formedness.

Importantly, our Japanese speakers had a more difficult time with –fricative + liquid– onsets, and this is predicted by OT (as well as by the MSD model) because the distance in sonority between these two consonants is less than that between the consonants in the other two onsets investigated. That is to say that our learners have not yet acquired the O SON value, which would allow a more harmonic parse of –fricative + liquid– onsets. Again, this is the same insight as captured by the MSD model.

Onsets: Epenthesis versus Deletion. One effect in our data that the MSD model does not capture is that when both sets of learners err on complex onsets, they are more likely to epenthesize a vowel than to delete a consonant. Differences in rates of deletion relative to epenthesis have been discussed elsewhere (e.g., Anderson, 1987; Eckman, 1981; Major, 1987; Tarone, 1980; Weinberger, 1987). OT explains this tendency to overparse onsets via the relative ranking of PARSE and FILL. In both languages, PARSE dominates FILL, which means that it is more harmonic to have an unfilled syllable position (which takes a vocalic segment upon output) than to leave a segment of the input unparsed or unanalyzed in the syllable structure. An alternative explanation is given by Weinberger (1987, 1994) in which he proposes that epenthesis and deletion strategies are a function of an "avoid ambiguity" strategy (likened to overparsing) which is task-dependent and proficiency-dependent. It is possible, then, that the subjects from this experiment overparsed onsets because of their awareness of (attention to) the two consonants. However, given the task demands (i.e., a focus on syntactic grammaticality), it is also possible that learners did not attend to the onsets as much as would be needed by an "avoid ambiguity" strategy. Furthermore, it may be that the Weinberger analysis and the OT one are quite compatible, suggesting a potential connection between OT and psycholinguistic effects such as attentional demands. However, as stated earlier, in the absence of a well-defined model that encompasses both grammatical and psycholinguistic effects in L2 sound patterns, we cannot speculate further on this.

ESL Syllables: Codas. The MSD model accurately predicts that our ESL learners as a whole produced –liquid + stop– codas more accurately than –liquid +

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fricatives–, which in turn are produced more accurately than the –liquid + nasal– codas, due to constraints on sonority distance between the two consonants. OT captures this constraint through the generalized margin sonority (M SON) constraint (see Colina, 1995), which we assume can be expanded into O(nset) SON and C(oda) SON. If the L1 allows complex codas (word-finally), then it selects a value for C SON, which indicates the minimum distance in sonority that consonants in the same syllable position can have. Any sonority distance less than the value for C SON is not well formed. Because the sonority distance decreases going from –liquid + stop– to –liquid + fricative– to –liquid + nasal–, a language without these coda clusters would find them increasingly less harmonic, thus more difficult.

We did find, however, subtle language-specific effects in our learners' coda error types, effects that are unanalyzable within the MSD model. Next, we discuss how these effects may be understood within an OT framework.

Japanese. We first restate the coda rankings we derived for Japanese: *COMPLEX^{cod}, PARSE ≫ FILL ≫ -COD. That complex codas are difficult for these learners is completely predictable due to the high ranking of *COMPLEX^{cod}. However, the native grammar ranks PARSE above FILL, indicating that it is more harmonic to epenthesize than to delete unlicensed codas in Japanese. This is not what we observe in our L2 speakers' data. Rather, the preferred parse, by far, for complex codas is one that underparses, or deletes a segment, suggesting that FILL should dominate PARSE. Furthermore, the Japanese learners prefer to delete the first consonant (the liquid) in the cluster, not the second. Let us consider three possible explanations as to why our learners are doing something other than what their native grammar ranking predicts.

First, deletion in the coda may be a result of misperceptions, as suggested earlier. In this case, the hypothesis is that Japanese learners do not perceive the liquid as a consonant so that the actual input into their grammar does not contain the liquid (that is, a word like *ark* may be perceived and input into their grammar as /aak/ and *alk* is input as /awk/). If this is the case, then there would be no violation of *COMPLEX^{cod}, and we could assume that the learner is at a stage of acquisition in which the constraint on nonnasal codas, *M^{cod}/C$_{nonnasal}$, is demoted such that a violation in PARSE/FILL is worse than a violation in the constraint on associational harmonies. This possible interpretation provides an important research question on the "activity" (or resilience) of constraints[21] on associational harmonies relative to those which define structure (PARSE, FILL).[22] The tableau in (19) demonstrates this potential state of affairs.

(19) Analyses of (misperceived *ark*): input as /aak/

/aak/	*COMPLEX^{cod}	PARSE	FILL	*M^{cod}/C$_{nonnasal}$
⇒ aak				*
aa.k◊			*!	
aa<k>		*!		

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A second possibility as to why L2 learners seem to delete segments in complex codas as opposed to using epenthesis may be due to a universally dominant effect in early language acquisition, which favors coda underparsing rather than overparsing. Thus, languages like Japanese, which eventually rank PARSE over FILL, force an additional reranking to be learned. Weinberger (1987) captured this generalization on over-/underparsing for L2 learning, that is, that less proficient learners are more likely to underparse segments than to overparse, an effect that is widely observed in L1 acquisition. Counterevidence to this interpretation comes from the learners' perceptual abilities. Children, for example, can easily distinguish words like /slip/ and /sip/ but may not be able to produce this distinction due to production constraints. This suggests that the problem lies, not in the perceptual abilities, nor the grammar, rather in the production system. The output of the grammar may in fact evaluate as most harmonic the parse that is consistent with the native H-EVAL, but other postgrammatical effects modify the word, forcing deletion to be the preferred coda simplification strategy. Ruling out this possibility can only be done when we have a viable production model to test it against.

A final possibility is that English liquids in the Japanese ESL grammar are more harmonic when parsed as a syllable peak than when parsed in the margin, suggesting the following constraints on associational harmony: *M/liquid$_{english}$ ≫ *P/liquid$_{english}$. Thus, for an input like /ark/, the L2 H-EVAL will evaluate aR$_{nucleus}$k as more harmonic than a$_{nucleus}$Rk. This could also be explained easily by appealing to constraints on syllable position complexity: *COMPLEX^{cod} is ranked high, so violations of it are serious, whereas violations of *COMPLEX^{nuc} are more tolerated, as is evidenced by the frequent occurrence of complex nuclei in Japanese words. Thus, if liquids are peak-preferring, they would avoid serious violations in syllable structure constraints. However, this possibility would make the prediction that English liquids can occur in simplex peaks as well for these learners. Whereas we doubt that this is the case, it does remain to be tested.

At this point in time, we cannot argue strongly in favor of one of the preceding interpretations over another, particularly due to lack of experimental evidence. However, it is important to highlight that, because of its relatively high level of definition, OT provides us with a specific starting point for formulating hypotheses about error types which can be subsequently tested. In this way, OT not only captures the insight of previous grammatical frameworks, particularly a principles and parameter (re)setting one, but it also allows us to hypothesize the nature of error types in our ESL learners.

Spanish. Our Spanish speakers exhibited systematically different error types than our Japanese learners with respect to complex codas. The native ranking for Spanish codas is repeated here: CODA COND, *COMPLEX^{cod} ≫ PARSE ≫ FILL. Unlike Spanish onsets, the constraint on complex codas (word-finally) is ranked high, so we expect the learners to have a higher rate of coda errors than onset ones, which is what we see in our data. With respect to PARSE and FILL, we have the same problem as we had in Japanese. The native ranking predicts that overparsing (epenthesis) is more harmonic than underparsing (deletion) in codas. The difference here, however, is that Spanish speakers were more likely to delete the second consonant

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of the complex coda, not the liquid. Here we explore the potential interpretations of this unexpected effect.

First, it may be that the second consonant is not salient to these learners so that it does not factor into the input into the grammar (that is, *alt* is perceived as /al/). This seems an unlikely possibility given the salient nature of obstruents and nasals (which formed the second consonant). Furthermore, Spanish does allow these obstruents or nasals in coda position, a fact that should facilitate the perceptual acuity of this sound in this context for these speakers. Finally, our data from Task 1 suggest that learners do not have difficulty hearing the second consonant in the cluster: They rarely choose *kal* over *kalt* when identifying the input /kalt/. This possibility, we believe, does not need to be explored further.

A second interpretation is that the grammar does, in fact, evaluate the most optimal candidate to be the one that respects the PARSE over FILL dominance, but that grammar-external, production-based rules modify what actually is produced. As already discussed for Japanese, we cannot support nor rule out this possibility in the absence of a discussion of a particular production model, which we consider to be beyond the scope of this paper.

The third possibility, which we believe is the most viable, is that deletions of obstruents are merely respecting the constraint rankings that have been instantiated from the native grammar. Spanish allows only coronal consonants in codas, and Colina (1995) identifies this as a special high-ranking Coda Condition that must be satisfied in the OT grammar. Thus, it is preferable to parse a coronal coda than a noncoronal. Because the liquids are coronals, they satisfy the condition, and because the second consonant was sometimes not a coronal (i.e., labial or velar), it violated the condition. The tableau in (20) shows how this evaluation—based on an L1-instantiated ranking—works.

(20) ESL coda consonant clusters in Spanish

/alk/	CODA COND	*COMPLEX	PARSE	FILL
alk	*!	*		
al.◊k	*!			*
a<l>k	*!		*	
⇒ al<k>			*	

In cases where the second consonant was a coronal (e.g., /alt/) then the two candidates al<t> and a<l>t should be equally harmonious. Even when we appeal to the Possible Coda Parameter (Prince & Smolensky, 1993, p. 159), which says that "the possible codas are those segments with sonority value less than or equal to a cut-off parameter π_{cod}," we see that the /t/ is every bit as harmonious as the /l/ in that position because its sonority value is less than that of the liquid. However, we do know that /t/ does not occur as a word-final coda in the native vocabulary, whereas /l/ occurs frequently. It may be that the preceding parameter needs to be

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constrained for Spanish to define a range of sonority values that can occur in this position. That is, $\pi_{cod} = l, r \leq \cdots \leq s, d$. Clearly, this and other alternatives on the unique behavior of /t/ with respect to Spanish codas need to be explored more fully elsewhere.

The preceding discussion and ranking, however, still do not explain why underparsing is the preferred strategy in these speakers' L2. It may be that, as discussed earlier, PARSE and FILL get reranked relative to each other in early stages of acquisition. Exactly why this is done, in addition to further experimental evidence to support this, is a critical topic for future research. It may also be due to production-level constraints on segment sequencing. On the surface, this would seem to complicate the articulatory process in general because it entails that the grammar outputs an optimal description that subsequently gets reevaluated and modified at a later level. Would not this reevaluation and modification entail another domain of constraints, at a grammar-external level? If so, then how do we distinguish these constraints from grammar-internal ones?

To summarize, in this section we have raised several issues about the exact nature of patterns in error types. Some of the patterns can be attributed to transfer of constraint rankings (and coda conditions) from the L1, whereas others are the result of universally dominant constraint rankings. In the next section, we discuss why we believe OT is an improvement upon the previous analyses presented to account for L2 syllable structures.

OT as an Alternative to Previous Proposals on L2 Syllables

The two previous proposals of L2 syllable structure, Broselow and Finer (1991) and Eckman and Iverson (1993), are able to account for developmental effects in L2 syllables by appealing to generalizations and constraints on sonority sequencing. Only the Broselow and Finer proposal included an account of transfer effects, especially as they interact with developmental ones, in L2 syllables. As stated earlier, Eckman and Iverson criticized the MSD model, citing, in part, the lack of clear evidence in Broselow and Finer's data for transfer effects. In this study, we wanted to further test for evidence of transfer in L2 syllables, using at least one language that should unambiguously exhibit those effects in consonant cluster onsets, and for this reason, we chose the MSD model as the framework for our hypotheses. Furthermore, we wanted to see how well the MSD model accounts for consonant clusters in codas.

In addition to developmental effects (non-language-specific), we found significant evidence for transfer effects. These effects were apparent not only in the rate of errors across the various cluster types, but also in the type of errors that were made, something which the MSD model, in its current form, does not predict. To capture not only the insights from the previous two proposals, but also the additional data that we presented, we looked to an alternative framework and found that it could account for a greater range of phenomena in L2 syllables. In this section, we discuss how OT goes beyond the previous two analyses, allowing us greater precision in describing transfer and developmental effects in L2 syllables.

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Accounting for Language-Specific Effects in L2 Syllables. OT provides a framework within which we can understand the interaction between transfer and developmental effects. In its current form, the Eckman and Iverson account, which uses typological markedness and the sonority dispersion principle (Clements, 1990) to account for their own and for Broselow and Finer's data, does not account for the transfer effects we obtained and, thus, does not clearly account for the interactions between transfer and developmental effects. For example, Spanish has a language-specific constraint on which fricatives may form consonant cluster onsets: Only /f/ freely combines with a liquid to form an onset. The other (voiceless) fricative(s), /s/ and /x/ (in some dialects), need to be ruled out. Furthermore, codas are more restricted than onsets, as a result of not only sonority sequencing constraints but also language-specific licensing ones. Whereas generalizations on sonority sequencing may tell us why learners are having difficulties with certain consonant clusters, they do not tell us how the difficulty is resolved. In our data, coda clusters were resolved in a language-specific manner: Spanish speakers were more likely to delete the obstruent, whereas Japanese speakers were more likely to delete the liquid. We attribute these differences mostly to language-specific restrictions on which sounds are more likely to occur in the syllable nucleus and coda in each language. Without a specific role for language-specific effects, such as licensing restrictions, the Eckman and Iverson account cannot clearly distinguish transfer from universal effects. In turn, we cannot observe, nor even propose hypotheses on, how the two effects interact throughout stages of acquisition.

The MSD model, on the other hand, does allow us to show the independence of and interaction between transfer and developmental effects in the accuracy rates of L2 syllables. But, as discussed earlier, Eckman and Iverson pointed out that the MSD model overgenerates the range of structures that actually occur in certain languages. Our analysis of Spanish speakers' complex onsets in English supported this: Liquids are less sonorous than glides, so –stop + liquid– onsets have a lower sonority distance than –stop + glides–. According to the MSD model, then, if a language has –stop + liquids–, then it also has –stop + glides–. However, Spanish has –stop + liquid– onsets but not –stop + glides–. Spanish speakers of ESL transferred their –stop + liquid– onsets but were unable to do so with –stop + glides–, performing significantly worse on the latter category of onsets. To account for the facts in Spanish, the MSD model would need to show how the proposed universal tendency for languages to have –stop + glide– clusters if they have –stop + liquid– ones can be overridden in some languages, an effect that is also transferred into their L2.

In addition, the MSD model in its current form is not well equipped to deal with more clear language-specific licensing restrictions, in part, because the model is intended only to account for sonority sequencing in consonantal clusters. Presumably, further definition of language-specific sonority sequencing restrictions is possible with the MSD model, but still we could not explain error types: When clusters are simplified, they are done so in a language-specific fashion. Thus, the previous two models would need to be enhanced to account for language-specific licensing conditions on syllable positions.

OT, on the other hand, accounts for licensing conditions by providing formalisms

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to describe which segments are more or less harmonic in which syllable positions, via the associational harmonies, as described earlier. These harmonies are dictated by universal and language-specific rankings, the latter potentially overriding the former. Thus, OT can account for learner error types in complex codas: Spanish speakers are more likely to retain the liquid (and delete the second consonant) because liquids are more harmonic than, for example, obstruents in coda position; Japanese speakers are more likely to underparse the liquid or misparse it with the nucleus. In short, OT provides a framework within which we can ask specific questions about prosodic licensing effects, which will lead to specific hypotheses and, thus, eventually allow us to do focused tests on transfer effects in L2 syllables.

Accounting for Epenthesis in Onsets versus Deletion in Codas. OT may account for other types of errors, not necessarily related to transfer or universal constraints on sonority sequencing, unlike the previous two accounts of sequencing in clusters, which do not account for any specific type of error (only error rates in specific cluster types). For example, we found a significant difference in error types between onsets and codas: Subjects were more likely to use epenthesis to simplify onset clusters and more likely to use deletion to simplify codas. (As already discussed, this result has been found by other L2 researchers.) That onsets are more likely to undergo epenthesis, or be overparsed, and codas are more likely to undergo deletion, or be underparsed, is captured by the relative ranking of specific constraints. No theory-external mechanisms need be posited because this effect falls out as a result of the basic components of the theory. Once again, OT goes beyond the previous two analyses to address a greater range of phenomena in L2 syllables.

Generalized Mechanisms to Account for All Domains of Phonology. The two previous analyses on L2 syllables accounted for consonantal sequencing in complex onsets. They made no claims about other levels of phonology, nor could they have accounted for potential influence on L2 syllables from other levels of phonology. OT, on the other hand, does account for other levels of the phonology, and their potential influence on L2 syllables, by proposing one basic set of assumptions about the working of the entire grammar. For example, the formalisms that derive associational harmonies are not particular to the relationship between segments and syllable positions; rather they are generalized schemata that define well-formedness at all levels of the phonology. OT accounts for universal effects in sonority sequencing in addition to language-specific ones, all within a singular set of assumptions about the workings of the phonology. Because of the generalized mechanisms, OT can in principle account for these same effects at other levels of the phonology (e.g., metrical, segmental) without having to propose a new account. Interactions among the levels of phonology are defined by universal constraints. Whether or not the interactions are observable in a particular language is based on how prominent the relevant constraints are in the grammar. Because of basic, core assumptions on the working of the grammar, there is no need to incorporate other models or analyses to account for transfer and developmental effects in all levels of

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the phonology or for effects from other levels of the phonology in L2 syllables, as would be necessary in the previous proposals discussed.

Extensions to L2 Acquisition Research. Although this article and the previous two articles discussed do not directly address acquisition, we can begin to speculate on the usefulness of OT in accounting for how transfer and developmental effects change over time, in light of the fact that acquisitional issues are being explored elsewhere in OT research (e.g., Tesar & Smolensky, 1993). To begin, it has been proposed that nonnative borrowings (foreign words: assimilated vs. unassimilated) can have a different constraint ranking as compared to that of native words within the same lexicon (Itô & Mester, 1994, 1995). That is, a lexicon may have multiple rankings of constraints associated with it, depending on the "nativeness" of the words or how well they are assimilated into the grammar. Words that are not well assimilated are subject to a nonnative ranking, whereas well-assimilated words are subject to a ranking that is consistent with that of the native vocabulary.

Extending this to L2 acquisition, we can speculate that the job of the learner is to figure out the nonnative rankings associated with the L2. One main assumption would have to be made, and that is that the L2 learner begins with the L1 constraint ranking. That is, the L1 phonology is wholly transferred into the initial state of the L2 (see also Archibald, 1993; Broselow & Finer, 1991; Broselow & Park, 1995). As exposure to L2 forms increases, constraints get reranked when necessary to better conform to what is input into the system. The actual details of how constraints may get promoted or demoted are beyond the scope of this paper. Importantly, however, is that it is through the reranking of constraints that learners will exhibit varying levels of proficiency, which may lead us to more explicit characterizations of the stages of interlanguage development. One appropriate direction for research on L2 acquisition, then, is discovering which of the universal constraints get reranked and when, relative to each other. If input is the trigger for reranking, then we can also explore what kind of input is effecting changes and when.

That we can examine specific constraints as they undergo reranking in order to be more consistent with the L2 input provides a framework to account for the interaction of transfer and developmental effects. That is, by studying specific constraints and how and when they rerank during acquisition, we can gain a better understanding of the conditions under which transfer effects override developmental ones and, conversely, when developmental effects override transfer. In so doing, we can begin to give a linguistic-theoretic interpretation to Major's (1986, 1987, 1994) ontogeny model, which is based on experimental evidence that L2 learners have mostly transfer-related errors in early stages of learning, but that, over time, developmental errors become more prominent, whereas both taper off in advanced L2 speakers. If we assume that the L2 learner's initial state is the transferred L1 constraint ranking, we can then begin to address why transfer effects are prominent in early stages of acquisition.

With respect to these acquisitional issues, the OT framework is preferable to the other two analyses because it provides formalisms to account for grammatical well-formedness, as well as modifications to that well-formedness as a result of

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acquisition, all within a singular theoretical framework. There is no need to appeal to other formal models to account for transfer and UG-based effects within acquisition.

To summarize, whereas transfer and developmental effects are often identified as sources of errors or difficulty in L2 syllables, they have not been explicitly accounted for within a singular grammatical framework. We suggest that OT can account for the greatest range of phenomena to date and allows us to formulate specific, testable hypotheses on these effects. The two previous proposals discussed here are not as explicit in accounting for transfer and developmental effects in error types, particularly those associated with L1 licensing conditions and onset and coda error asymmetries. Furthermore, they are not as well defined as OT in terms of what effects changes in the grammar. It is the greater definition of OT that allows us to make specific, focused hypotheses on transfer effects, how they interact with developmental ones, and how this relationship changes over time.

CONCLUSION

In this article, we have provided empirical evidence that transfer effects are a significant part of L2 syllable structure and that they interact with developmental effects in ways that are not always obvious when we consider error rates alone. This evidence lends support to the MSD parameter-setting model of L2 phonology, because it accounts for both transfer and developmental effects within the same grammatical model. The results of our experimental study further support the notion that developmental effects dictate productions in the absence of positive transfer. However, our results go beyond the two previous, related studies in this area by providing evidence that (a) transfer does override developmental effects, as in our Spanish speakers' superior performance on –C + liquids– versus –stop + glides–, and (b) transfer effects surface not only in learners' error rates but also in their error types.

We proposed that using an OT approach to the grammar to interpret the preceding results provides a more well-defined hypothesis on the nature of these effects than previously offered. By using OT, we showed that Spanish and Japanese grammars differ only in terms of their rankings of universal constraints on syllable onsets and codas and that these differences were the basis of the systematic, language-dependent differences in these speakers' ESL error patterns. Certain language-independent differences in error types between onsets and codas can be attributed to relative constraint rankings that are universally dominant. OT, we argued, allows us to explain a greater range of effects in L2 syllable structures than the two related analyses previously offered.

We suggest that OT provides the most encompassing and explicit model of the naturalness of the interlanguage phonology to date. When two grammars are in contact, optimal forms are computed based on the relative ranking of universal constraints. In early stages of acquisition, the rankings are L1-based, but over time they become more like the rankings of the target language. Assuming a dynamic representation of the interlanguage phonology (e.g., Hancin-Bhatt, 1994a; Hancin-Bhatt & Govindjee, to appear; Puppel & Marton, 1991) allows us to account for the

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variation in learners' performance, variation that is explained in part by competing L1 and L2 grammars and in part by UG. This work, then, is a contribution to the growing set of studies on the dynamic interlanguage that highlights the complex interaction of transfer and UG-related effects.

(*Received 6 March 1996*)

NOTES

1. It should be noted that Spanish does have complex codas word-internally (e.g., *abs.trac.to,* "abstract"; *pers.pec.ti.va,* "perspective") but not word-finally, unless they are recent borrowed words. In other words, the constraint on complex codas word-finally may be a soft constraint.

2. Although Spanish has -C + glide- sequences, the glide forms part of the syllable nucleus, not part of the onset (see, e.g., Carreira, 1990; Colina, 1995; Harris, 1983). A simple illustration is as follows: *bwéno,* "good," versus *benéfiko,* "beneficent (doing good deeds)." When stress shifts off of the initial nucleus, it may lose its glide.

3. Note that if Spanish has a setting of 2, it should allow –C + glide– onsets, according to the MSD model, but it does not. This is an obvious problem for the framework that may be resolved through the addition of language-specific statements, but how this is to be done is unclear. This is briefly addressed later in the paper.

4. We remind the reader that these categories are based on the onset consonant clusters studied in Broselow and Finer (1991) and Eckman and Iverson (1993). Regarding the –stop + glide– cluster, both –stop + w– and –stop + y– were examined, as was done in the latter study. In the former study, only –C + y– onsets were tested. However, one reviewer points out the controversy over whether or not –stop + y– is in fact a complex onset in English. Davis and Hammond (1995) argue that /y/ glides generally form part of the syllable nucleus in English (e.g., *cute,* /kyut/), while /w/ glides generally form part of the onset (e.g., *queen,* /kwin/). While we acknowledge that this controversy is important, we cannot modify the current study (or set of materials) because, for comparability, the target items are based on items from the two previous studies and the general predictions of the MSD model. Furthermore, we note that subjects received a written version of the pseudowords with the glides written as either a /w/ or /y/ (i.e., no orthographic ambiguity). This, we suspect, would encourage the subject to parse the glide as a consonant forming part of the onset. We agree with the reviewer, however, that the controversy that the Davis and Hammond (1995) article raises provides an excellent research question for a future study of ESL syllables.

5. There is some controversy over using written materials to help subjects' listening, as appropriately pointed out by one reviewer, because orthographic input adds an additional variable to the study. Orthographic input can lead to what are known as "spelling pronunciations" that may not always represent natural language data (Altenburg & Vago, 1987). However, the use of written materials was deemed necessary here for various reasons. First, our subjects were not advanced or advanced intermediate learners, as in the other studies; we purposely chose subjects of beginning to intermediate proficiency, because transfer is greater at earlier stages of acquisition. Because of their lower level of English proficiency and because we were working with pseudowords to avoid previous learning effects, seeing a written version of the pseudoword helped keep the subjects on task with the prerecorded materials. Second, as discussed later, our subjects performed a grammaticality task, and this task would have been impossible for them to complete, including the repetition of the pseudoword, without a written version of the sentences. In the current absence of any model of L2 sound patterns that makes explicit predictions about the relationship of sound pattern processing and representations (but see Hancin-Bhatt, 1997), we must leave this issue aside temporarily, while acknowledging its potential effect.

6. Substitutions with native liquids, which happened infrequently, were not considered errors, because we were investigating syllable structure.

7. We should point out that the rate of error was higher in the subjects of our study as compared to those in the Broselow and Finer and Eckman and Iverson studies. This is due in part to task demands and to the lower proficiency of our learners.

8. One reviewer notes that although Japanese does not have –C + glide– onsets, it does have /y/ + V nuclear elements; thus, Japanese ESL learners may find –CyV– sequences easier than –CwV– because of a transfer effect. This would make them like the Spanish speakers who also have glides forming part of the syllable nucleus in their L1. Because the MSD model does not make a prediction about differences between –Cy– and –Cw– sequences, we did not consider them as separate –C + glide– category types. In fact, our subjects each produced six instances of –C + w– and six of –C + y–, and we found basically no difference in

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our Japanese speakers' error rates across the two types. On average, these subjects erred 1.7 times on –C + w– sequences and 1.5 times on –C + y–. However, we believe that, as our theoretical framework for predicting transfer becomes more sophisticated and the experimental techniques more refined, we can further explore this insight on possible differences in –C + glide– sequences in Japanese speakers' ESL.

9. It is important to note, as one reviewer observes, that fricatives may occur in Japanese clause-finally after devoicing and final vowel deletion (Vance, 1987). Because these are likely postlexical operations, we assume that fricatives are not lexically licensed in coda position but that they occur after specific phonetic processes. This complication serves to remind us of the complexity in studying L2 sound patterns: Phonetic processes and suprasegmental effects do interact with phonological knowledge to govern productions. The extent to which these effects govern L2 representations is clearly a problem worthy not only of experimental but also of theoretical exploration.

10. Note that we are not making a claim here about the *site* of vowel epenthesis in initial clusters, simply that epenthesis is the more likely repair strategy.

11. One reviewer also suggests that deletions seem to be more a function of "nonperception rather than a strategy in any sense." Our data from Task 1, however, suggest otherwise (i.e., nonperception may not be a significant factor in producing these complex onsets and codas). Discussion of this within an OT framework is in the section on ESL Codas.

12. Because our subjects performed an identification task, we can explore their perceptual errors to see whether, in fact, they mirror the production facts. Because Japanese speakers were more likely to delete the nonfinal liquid in codas, we can hypothesize that they are less able to hear a liquid in this position. For Spanish speakers, the opposite occurred, so if perceptual tendencies have an effect on L2 mapping, we expect that they do not have difficulty hearing liquids in word final clusters.

13. The purpose of this section is not to present an argument for OT but to merely present the basic tenets of the theory so as to situate the later discussions. The discussion here, as well as the subsequent analyses, is based on Prince and Smolensky (1993) and Smolensky (1994), unless otherwise stated. It should be noted that there have been amendments to and elaborations on the theory since then, but the basic premises remain the same.

14. They may be indirectly ranked through transitivity, where if $A \gg B$ and $B \gg C$, then $A \gg C$.

15. We qualify that this constraint is referring to syllable onsets here (see Colina, 1995). This constraint takes a different ranking in Spanish codas, as we will see subsequently.

16. See Colina (1995) for more thorough arguments.

17. This definition includes fricatives under the obstruent category, but this is an overgeneralization. Only –f + liquid– (e.g., *flotar,* "float"; *frío,* "cold") is fully licensed as an onset in Spanish. Essentially, all other –fricative + liquid– combinations would have to incur a more serious violation than –f + liquid–, meaning that the parameter value cited above needs greater refinement.

18. One reviewer questions the validity of using loanwords as evidence for native language rankings, citing, in particular, Itô and Mester's (1995) paper, which shows that different levels of borrowed words exhibit slightly different rankings, based on their source. The constraints they studied, however, defined licensing restrictions on voicing and geminates. In fact, the constraints defining syllable structures were undominated at all the different levels of native and borrowed words, suggesting that in fact native syllable structure rankings are quite resilient to reranking as a result of new patterns of input. Yip (1993) provides arguments specifically in favor of loanwords as evidence for native language rankings. Given this evidence, we believe that the evidence against using loanwords is weaker than the arguments for it.

19. Data on Japanese are from Itô (1989), Itô, Mester, and Padgett (1995), and Itô and Mester (1995). For this paper, we ignore the assimilation processes affecting the segments, but see Itô et al. (1995) for an analysis within OT.

20. Data are from Tsuzaki (1970). Coronal codas in loanwords are often deleted, indicating an interaction between the Coda Condition and PARSE and FILL, a problem that is left for future research.

21. See Smolensky (1993) for a discussion of constraint activity.

22. As a point of departure, Itô and Mester (1995) argued that differences between core (native words) and periphery (borrowed words) phonology is in how well they obey specific lexical constraints. They show how certain constraints related to segmental licensing were violated more readily by borrowed words than constraints on syllable structure.

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https://doi.org/10.1017/S0272263197003033 Published online by Cambridge University Press

APPENDIX A

PROFILE OF ESL SUBJECTS: SPANISH (S) AND JAPANESE (J)

Subject	Age	Approximate Level	Years Studied English	Months in U.S.	TOEFL Score[a]	% Correct Task 2
S1	41	Beginner	3	1	—	69
S2	25	Beginner	5	1	—	72
S3	25	Beginner	4	1	—	68
S4	25	Intermediate	1	1	507	75
S5	36	Intermediate	1	1	—	65
S6	23	Intermediate	6.5	6	487	85
S7	20	Intermediate	10	1	—	83
S8	35	Intermediate	1	8	—	61
S9	32	Intermediate	6	2	530	82
S10	30	Intermediate	7	2	—	64
J1	19	Intermediate	7	4	—	72
J2	19	Intermediate	8	14	450	94
J3	21	Intermediate	9	4	553	90
J4	19	Intermediate	6	3	—	65
J5	17	Intermediate	3	36	457	79
J6	20	Intermediate	10	4	470	94
J7	20	Intermediate	7	1	550	93
J8	20	Intermediate	6	4	—	78
J9	25	Intermediate	6	8	487	86
J10	18	Intermediate	6	24	—	96

[a]Some TOEFL scores are missing because not all subjects had taken the exam.

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APPENDIX B

MATERIALS: TARGET PSEUDOWORDS

	Codas			Onsets		
	C_{nasal}#	$C_{obstruent}$#	$C_{coronal}$#	#C_{nasal}	#$C_{obstruent}$	#$C_{coronal}$
1.	flen	traf	kyul	nem	bom	san
2.	san	rof	lar	meem	fum	lom
3.	pyun	slev	pid	nilm	pern	rorp
4.	slon	niv	nas	morm	goln	derk
5.	freen	kag	fles	niv	korp	rof
6.	lom	plok	prel	mup	virt	lar
7.	kwam	mup	mur	nalt	vap	lurf
8.	nem	tweeb	kled	malk	kag	silf
9.	bom	teg	frol	nas	pid	deerm
10.	meem	kyuk	twor	mur	geet	teg
11.	kren	vap	geet	mils	burs	tirf
12.	fum	plob	slat	nols	farf	rulp
	$C_{liquid}C_{nasal}$#	$C_{liquid}C_{stop}$#	$C_{liquid}C_{fricative}$#	#$C_{stop}C_{glide}$	#$C_{stop}C_{liquid}$	#$C_{fricative}C_{liquid}$
13.	klarn	trolt	lurf	pyun	kren	flen
14.	pern	nalt	tirf	kwam	klarn	slon
15.	deerm	pyulk	mils	kworm	praln	freen
16	kworm	rulp	burs	pyurm	triln	slern
17.	frulm	virt	kwelf	tweeb	traf	flerk
18.	nilm	flerk	silf	kyuk	prel	slev
19.	praln	korp	nols	pyulk	plok	fles
20.	slern	krelp	flars	twirt	plob	frol
21.	goln	derk	farf	kyulf	trolt	slat
22.	morm	twirt	kyulf	kwelf	kled	flar
23.	pyurm	malk	frels	twor	krelp	frels
24.	triln	rorp	plors	kyul	plors	frulm

https://doi.org/10.1017/S0272263197003033 Published online by Cambridge University Press

APPENDIX C

GRAMMATICALITY JUDGMENT TASK: SAMPLE ITEMS

1. Adverb Placement
   A. The soldier sang the *slon* proudly for her country.
   B. The soldier sang the proudly *slon* for her country.
2. Case (nominative, objective, possessive)
   A. Mary hopes they are ready to *frulm* today.
   B. Mary hopes them are ready to *frulm* today.
3. Agreement
   A. The teacher believes the student does her *nalt* on Saturday.
   B. The teacher believes the student do her *nalt* on Saturday.
4. *Do*-Support
   A. I wonder what *mup* ate that was so hot?
   B. I wonder what did *mup* eat that was so hot?
5. *Aux* Inversion
   A. Everyone likes who Rosa is talking to in the the *kled*.
   B. Everyone likes who is Rosa talking to in the *kled*.
6. *That*-trace Effects
   A. Who do you believe ate the *rorp* on the table?
   B. Who do you believe that ate the *rorp* on the table?
7. Word Order
   A. Shoji thinks that *traf* is a colorful flower.
   B. Shoji thinks that *traf* a colorful flower is.

https://doi.org/10.1017/S0272263197003033 Published online by Cambridge University Press

APPENDIX D

TASKS

Task 1: Identify What You Hear

In this task, you will listen to words which sound like English words, but which are not real words. You will be given a list of possible spelling correspondences of the word on this sheet. Listen to each word and identify what you hear by circling one word in the appropriate set on this sheet. This task goes fast, so you should try to work as quickly as you can. If you are not sure which 'word' you heard, make your best guess. Please do not leave any numbers unanswered. You cannot listen to any items over again.

Examples:

1) LISTEN: *basek*
   CIRCLE: a. baseka
   b. basek
   c. bask
   d. baska
   e. brask

2) LISTEN: *plark*
   CIRCLE: a. pelarek
   b. pelark
   c. plarek
   d. plarka
   e. plark

3) LISTEN: *moot*
   CIRCLE: a. moota
   b. moot
   c. moo
   d. emoo
   e. emoota

Task 2: Listen and Say Correct Sentence

In this task, you will hear two sentences spoken for each number. One sentence is a good English sentence, the other is not good. After listening to the two sentences, decide which one is good and repeat that sentence as quickly as you can. You may not know all of the words in the sentence, but you should answer the questions as best you can. You may use this sheet to read the sentences that are being said. This task goes fast, so please try to answer as quickly as you can. Please respond to every number. You may not listen to any items again.

Examples:

1) a. Only dogs are allowed in the narpa park after dark.
   b. Only dogs is allowed in the narpa park after dark.
2) a. All the pictures were kalat by he.
   b. All the pictures were kalat by him.
3) a. The old man looked angrily at the rales child.
   b. The old angrily man looked at the rales child.
4) a. Joni likes with John to dance the golku.
   b. Joni likes to dance the golku with John.

https://doi.org/10.1017/S0272263197003033 Published online by Cambridge University Press

APPENDIX E

BACKGROUND QUESTIONNAIRE

1. Name _____ 2. Age _____
3. Country of origin _____
4. Area of country (south, north, east, west, central)/city _____
5. Mother tongue/First language _____
6. Number of years studying English _____
   A. Number of years in your country _____
   B. What program in your country? _____
   C. Was your teacher a native English-speaker? _____
   D. Number of years/months in the U.S. _____
   E. Age when you began studying English _____
7. TOEFL score _____ date of exam _____
   TOEIC score _____ date of exam _____
8. What level are you in your Intensive English Program? (Circle One.)
   Beginner Intermediate Advanced
9. Have you ever had English pronunciation training? (Circle One.)
   Yes No
10. Do or did you speak or study any languages other than English and your native language? (Circle One.)
    Yes No
    A. If Yes, which language(s)? _____
    B. How well do you know these other languages? (Circle One.)
       Beginner Intermediate Advanced
11. Is your hearing normal? (Circle One.)
    Yes No

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