

Reranking Stages in OT Analysis of the Acquisition of Japanese as a Second Language

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This investigation has two goals: (1) to identify developmental stages in the acquisition of Japanese as a second language by native speakers of English and (2) to account for these stages in the Optimality Theoretic framework (Prince & Smolensky, 1993) and to test the predictions of the Robust Interpretive Parsing/Constraint Demotion Algorithm (RIP/CDA) language learning mechanism proposed by Tesar & Smolensky (1996), to account for the findings. The study explores the syllable structure of Japanese productions of native speakers of English learning Japanese as a second language in order to isolate and characterize acquisitional stages in the learners' developing interlanguage (IL) grammars. The data support the prediction that these acquisitional stages can be neatly characterized as the reranking of constraints as the learner's grammar reorganizes to conform to the second language input. However, the utility of the RIP/CDA to account for this development is challenged as it cannot account for what motivates the IL reorganization stages apparent in the subjects' development.

1. Introduction

Optimality Theory (OT) has become the dominant framework in phonology, and is becoming increasingly popular in work in other subfields of linguistics, including syntax and morphology (Prince & Smolensky, 1993). Second language acquisition (L2A) researchers and theorists have begun to investigate the utility of OT as a theory able to account for L2A phenomena, as the utility of OT rests extensively in its ability to explain language variation, an issue of interest to language acquisition researchers, and several recent L2A studies have adopted the OT framework to explain interlanguage (IL) development and variation (Hancin-Bhatt & Bhatt, 1997a,b; Davidson, 1995; Bhatt, 1998). The present study is intended to contribute to empirical work in L2A by identifying discrete stages in the acquisition of the L2 Japanese phonological system by native speakers of English learning Japanese as a second language (JSL). A second goal of this work is to test the utility of the Robust Interpretive Parsing/Constraint Demotion Algorithm (Tesar & Smolensky, 1996) to account for this L2 development. The results of this study indicate that the non-target-like productions of syllable onsets and codas by the L2 Japanese learners reflect acquisitional stages in their developing Japanese phonological systems,

and that these acquisitional stages are neatly characterized as reranking stages within the OT framework. However, the data raise questions about the ability of the RIP/CDA to explain this L2 development.

This paper is organized as follows: Part two presents a review of the literature, including overviews of Optimality Theory, Optimality theoretic accounts of Japanese and English syllables, previous studies of L2 syllables in the OT framework, the Full Transfer/Full Access Hypothesis of Schwartz & Sprouse (1996) and the Robust Interpretive Parsing/Constraint Demotion Algorithm proposed by Tesar & Smolensky (1996). In part three I describe the present study; in part four, the results, and in part five, I discuss the findings and the implications of this research for the development of a theory of L2A.

2. Literature Review

2.1. Optimality Theory: An Overview

Optimality Theory (Prince & Smolensky, 1993) is a theory of constraint interaction. Under the assumptions of OT, the innate language endowment, or Universal Grammar (UG), is composed of a set of constraints on linguistic structures and a set of FAITHFULNESS (FAITH) constraints which ensure that surface structures maximally reflect their underlying forms. These constraints are violable and are often in conflict with each other, and these conflicts are resolved by the language-specific hierarchical ordering of the constraints, such that a violation of a dominating constraint is more serious than a violation of any or all of the lower-ranking constraints. Constraint rankings are language-dependent and the range of all possible linguistic structures is captured within the variant rankings. Thus the relative ranking of constraints determines the grammatical features of a language, differences among languages result from different constraint hierarchies, and learning a language is learning the constraint ranking of the

language.

(1) The operation of the grammar in OT

/input/ → GEN (candidate set) → H-EVAL → [output]

Figure 1 demonstrates the operation of the OT grammar: an input is fed into a generator (GEN) which generates all possible parses of the input, called candidates. Each candidate is then evaluated by the Harmony Evaluator (H-EVAL), which determines the most harmonic, or the optimal candidate based on the constraint hierarchy of the language. The optimal candidate, the one which has the least serious constraint violations, is the output of the system, and what the speaker produces.

2.2. The Full Transfer/ Full Access Hypothesis

Previous work has argued that the initial state in L2A is the final state of L1 acquisition (the Full Transfer/Full Access model of Schwartz & Sprouse, 1996; Hancin-Bhatt & Bhatt 1997a,b; Davidson, 1997; Bhatt, 1998). In the OT framework, then, the initial state in L2 acquisition is a full instantiation of the native language constraint hierarchy (full transfer). Subsequent L2 input feeds a language learning mechanism which in turn inspires the IL grammar to restructure in order to conform to the L2 input, and the restructuring is guided by UG (full access). This investigation adopts the Full Transfer/Full Access model of the L2 initial state; native speakers of English begin the L2 acquisition of Japanese with a full instantiation of the English constraint hierarchy. A mechanism designed to explain the subsequent UG-guided restructuring is presented in 2.5.

2.3. Constraints on Syllable Structure in OT: English and Japanese Syllables

This work focuses on the interaction of two kinds of constraints: those that require the optimal candidate to maximally reflect the input, called FAITHFULNESS constraints (FAITH), and two structural constraints on syllables, *COMPLEX and the CODACONDITION, collectively referred to as SYLLSTRUC constraints.

(2) Constraint Descriptions (1)

FAITHFULNESS (2)	FAITH	requires that the output match the input
*COMPLEX	*COMPLEX	prohibits consonant clusters in the same syllable position
CODACONDITION	CODACOND	for Japanese; allows only place-linked mora segments in codas (Ito & Mester, 1995)

*COMPLEX prevents intrasyllabic consonant clusters in the output. When *COMPLEX ranks higher than FAITH in a language, as it does in Japanese, the language does not permit intrasyllabic consonant clusters. And when FAITH outranks *COMPLEX, intrasyllabic consonant clusters such as complex onsets are permitted, as in English.

CODACOND for Japanese restricts the segments that can appear in codas to place-linked mora segments. Place-linked mora segments in Japanese are the mora nasal as in the Japanese word for book, /hoN/, and the first segment in a geminate (noted here as /C/), as in the Japanese expression /jyuCpun/ (or [jyuppun]), or “ten minutes.” The CODACONDITION prevents all other codas in Japanese, as it outranks FAITH (see figure 4). In contrast, English allows a variety of segments in coda position, as in the words *path* and *chair*, indicating that FAITH outranks CODACOND in the English hierarchy (see figure 5 for the English hierarchy).

(3) Syllable Structure Constraint Violations in English

<u>*COMPLEX</u>	<u>CODACOND</u>
stop	hat
part	book
glue	trash

(4) The English Constraint Hierarchy

star/ 'star'	FAITH	*COMPLEX	CODACOND
☞ star		*	*
sar	*!		*
sta	*!	*	

FAITH >> *COMPLEX, CODACOND

(5) The Japanese Constraint Hierarchy

borrowed from English 'beat'

/bit/	CODACOND	FAITH
☞ biito (3)		*
biit (4)	*!	

***COMPLEX, CODACOND >> FAITH**

borrowed from English 'free'

/fri/	*COMPLEX	FAITH
☞ furii		*
frii	*!	

Thus English permits a variety of intrasyllabic consonant clusters; Japanese does not, and while English permits a variety of syllable codas, Japanese has only the place-linked mora codas discussed above. As all Japanese phonemes are also phonemes in English, and Japanese has a

more restricted set of syllable structure possibilities, the syllables allowed in Japanese are a subset of those allowed in English.

2.4. OT and L2 Syllables

Within the OT framework, language acquisition is a process of reranking an initial constraint hierarchy to match the hierarchy of the target language (Tesar & Smolensky, 1996). In the case of native English speakers learning JSL, acquiring the limitations on possible syllables in Japanese requires reranking the initial English hierarchy to match the Japanese hierarchy, in other words, rearranging the initial English constraint hierarchy in which FAITH dominates the SYLLSTRUC constraints to the target Japanese hierarchy in which it is dominated by the SYLLSTRUC constraints.

2.5. Robust Interpretive Parsing/Constraint Demotion Algorithm (RIP/CDA)

Tesar & Smolensky (1996) propose the constraint demotion algorithm for language learning. The basics of the algorithm are as follows:

- (1) the developing grammar restructures according to the information provided by the target language input;
- (2) this process is error-driven: restructuring of the developing grammar occurs when the learner's grammar cannot assign a representation to the target language input;
- (3) through Robust Interpretive Parsing (5) the learner's grammar determines the crucial constraint-hierarchical difference responsible for its inability to accommodate the linguistic input and restructures accordingly; and
- (4) restructuring of the developing grammar is a process of constraint demotion.

The RIP/CDA was proposed for first language acquisition (L1A) and relies crucially on certain assumptions about the initial state in language acquisition. Tesar & Smolensky (1996) point out that in order to account for the availability of subset-principle-like effects in L1A, in the initial state FAITHFULNESS constraints must be ranked below the structural constraints to ensure that learners allow only the smallest set of structures called for by the input in the developing grammar. As the linguistic input consists almost exclusively of positive evidence (i.e., naturally occurring language), and positive evidence alone cannot inspire the *delimitation* of a set of structural possibilities, a language learner must have a built-in mechanism for making the most limited hypotheses (or assuming the smallest inventory of structures) that the target language input indicates.

While the constraint demotion algorithm was not originally proposed to account for L2A and many factors distinguish L2A from L1A, (i.e., L2 learners are older, they have already acquired a language, and their final state is rarely if ever native-speaker competence), it is nonetheless important to test its applicability to a range of language acquisition situations. This is especially the case with a model which proposes a mechanism responsible for linguistic development, as Tesar & Smolensky's (1996) RIP/CDA does. Despite the apparent differences between L1 and L2 competencies, a theory of grammar and language acquisition that can account for both is desirable, as it is theoretically cumbersome to propose two entirely different mechanisms to account for L1 and L2 learning. It is thus a goal of this study to test the utility of the RIP/CDA to explain L2A.

2.5. Hypotheses

Given the assumptions that the initial state for learners of JSL is an instantiation of the native

English constraint hierarchy and that learning in OT is a process of constraint reranking, developmental stages in the learners' progress should reflect steps in the reranking of the relevant constraints. As discussed above, what native English-speaking learners of JSL must acquire is the prominence of the SYLLSTRUC constraints relative to the FAITH constraints.

Support for this hypothesis is evidence of different violation frequencies for the two SYLLSTRUC constraints in learners' Japanese productions. If subjects produce fewer violations of one constraint, this is taken as evidence that FAITH has been (or is in the process of being) demoted below that constraint, since structures prevented by a constraint ranked higher than FAITH will not be produced.

3. The Present Study

3.1. Subjects

Thirty-nine native speakers of English in a first-semester undergraduate Japanese course with no formal training in the phonology of Japanese provided the data reported here figure 6. A native speaker of Japanese also performed the task as a control to confirm assumptions about the native Japanese constraint hierarchy and target-like performance.

3.2. Task

Subjects performed the task a total of three times over a period of two months, with approximately four weeks between sessions. In the task all subjects listened to the same series of three cassette recordings on which a native speaker of English pronounced a list of Japanese non-

words. After each item on the cassette, subjects were given five seconds (a) to say “yes” or “no,” where “yes” indicated that the word sounded like a possible Japanese word and “no” indicated that it did not, and (b) to repeat the word, correcting it if necessary to sound as “Japanese as possible.” Subjects were told that they would hear a series of Japanese words, but as all words were non-words, subjects were told that some of the words might be unfamiliar to them, but that it would not interfere with their ability to perform the task.

3.3. Items

There were forty non-words on each of the three cassette recordings. The targeted non-words were designed to violate the SYLLSTRUC constraints in order to elicit SyllStruc violations in the learners’ productions. Since the syllables allowed in Japanese are a subset of those allowed in English, the issue here is not whether or not they can produce Japanese syllables (because, as native speakers of English, they have no difficulty producing all Japanese syllables). Rather, of interest here is whether they have successfully *delimited* the number of possible syllable structures to conform to the Japanese set. In other words, whether they have successfully rearranged their IL Japanese grammars so that FAITH is ranked below the SYLLSTRUC constraints, thus preventing them from producing syllables which are not allowed in Japanese.

Of forty target items, sixteen contained no SYLLSTRUC violations (they served as distractors); sixteen contained CODACOND violations and sixteen contained *COMPLEX violations, with eight *COMPLEX violations in onset position and eight *COMPLEX violations in coda position (7). The *COMPLEX violations were split between onsets and codas in order to

control for effects resulting from unpredictable differences between subjects' performance on onset and coda positions. Examples of the items are provided in figure 7.

(7) Sample Non-Words (“.” indicates syllable boundary)

No Violations: fu.ran, shi.gi, mu.chin, ga.fu

***COMPLEX** Violations in *onsets*: bri.nu, kli.ma, maN.blo, shiN.sta

***COMPLEX** Violations in *codas*: ji.kint, ra.hamp, gomb.tsu, tont.fu

CODACOND Violations: fu.rit, nu.kuf, wa.kaz, fu.kap

By providing subjects with forms which are illicit in Japanese and asking them to “make them sound as Japanese as possible,” it was expected that they would make use of their knowledge of Japanese syllables to correct syllable structure, and violations of the SyllStruc constraints (productions which are illicit in Japanese) would indicate deviance from the Japanese constraint hierarchy in the IL grammars of the subjects.

4. Results

In each of the three sessions, subjects performed a variety of repairs on the target items, including epenthesis and deletion, indicating that they are to some degree aware of the differences between Japanese and English syllables. Instances of a lack of repair or repairs that resulted in illicit Japanese syllables were counted as violations, and these violations were analyzed for SYLLSTRUC violations.

Subjects produced a total of 1,441 items over the three collection periods. The results are shown in figures 8 – 10.

(8) Total Violations by Session

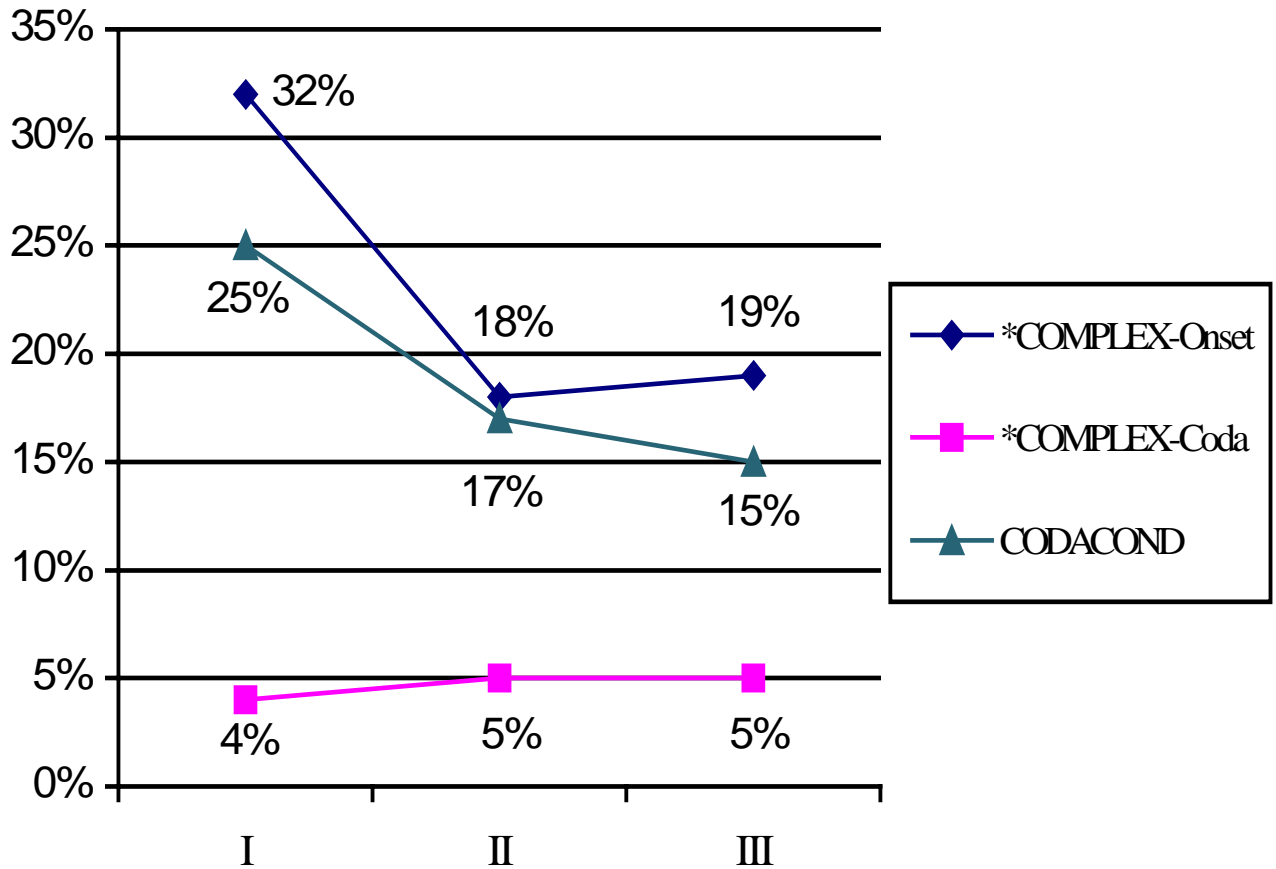
Session	Number of violations ¹	Number of productions	Percent violations
I	76	433	17.6
II	88	759	11.6
III	65	601	10.8

- I Session One (after one month of Japanese language study)
 II Session Two (after two months of Japanese language study)
 III Session Three (after three months of Japanese language study)

(9) Violation Type by Session (all values are percent violations)

Session	*COMPLEX-Onset	*COMPLEX-Coda	CODACOND
I	32	4	25
II	18	5	17
III	19	5	15

(10) Violation Type by Session



5. Discussion

5.1. The *COMPLEX Constraints

As can be seen in the table in figure 8, there was a general pattern of decline over time in the percentage of SYLLSTRUC violations in the subjects’ productions, indicating a trend towards convergence with the target language grammar. When the results are broken down by violation type in figures 9 and 10, we find a striking result: the difference between the frequencies of *COMPLEX violations in onset and coda positions in all three sessions. This difference is consistent with the proposal that there may be two separate constraints responsible for preventing

consonant clusters: one that prohibits them in onsets (*COMPLEXONSET) and one that prohibits them in codas (*COMPLEXCODA). For the remainder of this discussion, then, *COMPLEX is broken down into *COMPLEXONSET and *COMPLEXCODA. The two new constraints are described in 11.

(11) The *COMPLEX Constraints

*COMPLEXONSET	prohibits consonant clusters in onsets
*COMPLEXCODA	prohibits consonant clusters in codas

5.2. Distribution of Constraint Violations

The data presented in figure 10 indicate interesting acquisitional patterns. Perhaps most obvious is the consistently low occurrence of *COMPLEXCODA violations, ranging from 4% to 5% over the two-month period. *COMPLEXONSET has the highest violation frequencies, but drops drastically between the first and second sessions, leveling out between the second and third sessions. The CODACOND violations follow a similar pattern to the *COMPLEXONSET violations, only with a less dramatic drop between the first and second sessions.

These patterns can be interpreted in a number of ways. Most evident, however, is that very early in the process of acquiring JSL, at some point during the first month, the learners have already “acquired” the Japanese restriction against Complex codas. Their extremely low and consistent violation rate of *COMPLEXCODA (between 4% and 5% over the two-month period) relative to the other two constraints suggests that among the SYLLSTRUC constraints of interest in this study it is the first that becomes hierarchically prioritized (ranked above FAITH) in the IL

grammar of the learners (a proposal to explain why and how it is prioritized will be discussed later in the paper). Another striking result is the drop in frequency of violations of *COMPLEXONSET and CODACOND between the first and second sessions. This suggests that at some point during the second month of Japanese study the learners' IL grammars reorganize in a way that reduces the production of violations of *COMPLEXONS and CODACOND.

It is necessary to point out that the grammatical instability apparent in the findings is an expected and predictable phenomenon (Hancin-Bhatt & Bhatt, 1997b). The patterns identified here, rather than indicating completely ordered, stable grammatical hierarchies, actually reflect hierarchical *tendencies*. The highest violation rate, *COMPLEXONSET in session I, was only 32% out of the items designed to elicit *COMPLEXONSET violations, indicating that even the subjects' least target-like performance was still 68% accurate. For this reason, it cannot be concluded that IL development consists of a series of stable stages of grammatical reorganization. Rather, it is necessary to discuss these stages as having a tendency towards a particular hierarchy. For example, at session I, learners had an overwhelming tendency to avoid complex codas, indicating a strong tendency (for 96% of productions in this task) to have *COMPLEXCODA higher-ranked than FAITH. If we interpret the patterns represented in figure 8 as representing tendencies for certain constraint hierarchies in the developing JSL grammars of the subjects, we are able to best characterize their development as unstable constraint ranking reorganizations. Thus, in addition to providing a framework for discussing developmental stages in L2A, OT also provides a framework for discussing IL variation, as the formulation of the OT grammar is especially well-

designed to accommodate this instability.

5.3. Reranking stages in L2A

As discussed in Hancin-Bhatt & Bhatt (1997a,b) and supported by the results of the present study, OT provides a framework for discussing stages of development in L2A. The data reported here suggest not only that constraint hierarchies are reorganized in the learners' L2 development, but that there is an pattern to the restructuring. As mentioned above, the pattern is not one of complete and stable restructuring steps, rather it is one of developing tendencies towards particular constraint hierarchies in the IL grammar. Before addressing the issue of how or why the constraints re-rank in the way that they do, it is necessary to identify and present an OT account of these IL stages. According to the Full Transfer/ Full Access Hypothesis the SYLLSTRUC constraints are all ranked below FAITH in the initial state of these learners' L2 acquisition. During the first stage of development, *COMPLEXCODA is ranked above FAITH while the other two remain below it. At some point after the reorganization that results in *COMPLEXCODA being ranked above FAITH, both *COMPLEXONSET and CODACOND are ranked above FAITH, resulting ultimately in a constraint hierarchy identical to the Japanese hierarchy. These stages are shown in figure 12.

(12) Reranking stages in English L1 learners of JSL

Initial State: **FAITH** >> *COMPLEXCODA, CODACOND, *COMPLEXONSET

First stage: *COMPLEXCODA >> **FAITH** >> *COMPLEXONSET, CODACONDITION
 Target State: *COMPLEXCODA, CODACONDITION, *COMPLEXONSET>> **FAITH**

5.4. The RIP/CDA in L2A

The conclusions of this study lead to the questions of *how* and *why* the constraints re-rank in the way and order that they do to produce the IL stages discussed in 5.3. The RIP/CDA was proposed to explain both *how* and *why* constraints re-rank in L1 acquisition, but in this example of L2 development, the algorithm is only able to explain *how* the constraints re-rank, not *why* they do. The grammatical reorganization necessary to produce the stages observed here is not motivated by the RIP/CDA learning mechanism, as the RIP/CDA's operation depends on the inability of the existing IL grammar to assign a representation to the linguistic input. Given their English initial state in which FAITH is ranked above the SYLLSTRUC constraints, at no point in the acquisition of Japanese are these learners unable to assign a representation to Japanese input, as the English grammar can accommodate all Japanese syllable possibilities. According to the mechanism, then, there appears to be no motivation for the particular grammatical restructuring that is found in this study—in other words, the IL grammar has no reason to restructure as long as it is able to assign a representation to all of the L2 input.

That we do see grammatical restructuring, then, still needs to be explained. This restructuring results in a series of grammars that delimit the range of syllable possibilities in the IL grammar, suggesting that in some way the complete lack of certain elements in the linguistics input is interpreted by the developing grammar as indicating that such elements are excluded by the target

language grammar, inspiring IL restructuring that eventually — and ideally — prohibits it. This appears to be what is happening in the learners in this study, where the developmental stages indicate that the learners become increasingly inclined to prohibit structures not allowed by the target Japanese grammar over time.

5.5. The Role of Orthography in L2 Phonological Development

As it is clear that the RIP/CDA model of language learning alone is insufficient to account for the L2 phonological development of the subjects in this study, there must be other intervening factors that influence this development. One factor that may play a role in the apparent delimitation of syllable possibilities in these learners is the orthography of Japanese.

The Japanese language employs three orthographies. The first, called *katakana*, is a syllabary used to write loanwords and onomatopoeic expressions. The second, *hiragana*, is also a syllabary used in Japanese texts to write function morphemes, although it can also be used to write all Japanese words. *Hiragana* and *katakana* represent the same set of syllables, only they use different characters for each. The third, *kanji*, is a morphographic writing system adopted from Chinese, and is used to write content morphemes. The subjects in this study, in their first semester of Japanese language study, learn to read and write in *hiragana* -- *katakana* and *kanji* are taught later, and students initially use *hiragana* for all of their Japanese writing. I propose that learning *hiragana* may play a role in their developing understanding of the restrictions on Japanese syllables that is reflected in their improved performance on the judgment and repetition task over time. As it is a CV syllabary, *hiragana* cannot represent Complex onsets or codas, and

the only segments available to represent codas are the special characters for the mora segments /N/ and /Q/. Thus learning the *hiragana* writing system may provide the learner with a type of evidence that inspires restructuring by a language learning mechanism as it indicates by its limitation the restricted set of syllables permitted in Japanese.

The potential for the writing system of a language to provide L2 learners with information that is then used by the developing IL grammar to restructure in a way that more closely represents the target language phonology has important consequences for a model of L2 phonological development and a more general model of the L2 learning mechanism(s), as it further supports the claim that L2 learning is influenced by a variety of factors -- some available to the learners consciously and some whose influence is subconscious.

5.6. Further Research

Further research which investigates other sets of language learners may provide additional evidence of developmental reranking stages and may uncover evidence of universal reranking tendencies, in which certain constraints consistently rerank before others. The possibility of universal reranking stages has important implications for theoretical work in UG and L2A.

This study shows that the reranking involved in acquiring Japanese syllables by native speakers of English requires reranking FAITH relative to the SYLLSTRUC constraints *COMPLEXONS, *COMPLEXCOD, and CODACOND, from its initial position dominating the SYLLSTRUC constraints (the English hierarchy) to a position which is dominated by the SYLLSTRUC constraints (the Japanese hierarchy). I conclude that the reranking involved in

acquiring JSL can be discussed in terms of developmental stages in which FAITH is demoted below constraints on SYLLSTRUC in the order *COMPLEXCOD before CODACOND before *COMPLEXONS. This has important implications for OT, as it provides further evidence of the theory's utility in accounting for developmental phenomena in L2A. However, the proposed RIP/CDA model of language learning by Tesar & Smolensky (1996) cannot explain the motivation behind this restructuring, suggesting that (a) the model is an insufficient account of language learning; (b) L1 and L2 acquisition are controlled by separate and distinct language learning mechanisms; or (c) the RIP/CDA is operative in L2A, only it operates in concert with other, L2A-specific mechanisms (i.e., those which transform conscious learning into grammatical restructuring and thus account for the developmental patterns). As it is important to develop a model of L2A that incorporates the many factors that control L2 development, it is also important that the model be more than a descriptive tool; it must have predictive and explanatory power. For this reason, it is vital that L2A researchers and theorists explore models of language learning such as the RIP/CDA in effort to achieve a model that not only incorporates the multitude of complicated factors involved in L2A, but organizes them in a way that can account for the *process* of L2A and the nature of the responsible mechanisms within a theoretical framework which also allows for the detailed grammatical description of IL development (for example, OT).

Endnotes

1. This analysis of Japanese syllables is adapted from Ito & Mester, 1995.
2. Here, further description of FAITH is not included, although it is important to note that this constraint can be broken down into separate constraints which interact in important ways in other

aspects of the grammar.

3. Tensed vowels in loanwords are lengthened in Japanese.

4. Actually, both of these candidates do violate FAITH because of the vowel lengthening, but because the distinction being demonstrated concerns only the status of the coda, the violation of FAITH due to vowel lengthening is not important. Here I am only interested in whether the candidates' codas are faithful to the input coda.

5. For a detailed explanation of Robust Interpretive Parsing see Tesar & Smolensky (1996).

6. There were a total of 39 subjects who participated in at least one of the three data collection sessions. However, only twelve of the subjects provided useable data for all three sessions. Therefore, the number of subjects contributing to the results reported for any one of the sessions is much lower than 39, but all subjects who provided useable data were included in each analysis.

7. The total number of violations is higher than the total number of items because all instances of complex codas are also violations of the CODACONDITION.

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