Optimality Theoretic L2 Reranking and the Constraint Fluctuation Hypothesis: Coda Nasals in the L2 English of L1 Spanish Speakers

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1. Introduction

The fact that accented speech persists for adult L2 learners in spite of years of study, proficiency in other domains of grammar (such as syntax) and even phonetic training has led many to accept a phonological critical period as fact, an opinion based by and large on the abundance of anecdotal evidence. In fact, difficulties in production and/or perception lend evidence that the majority of adult L2 learners never fully master the phonological properties of their target language. However, as Flege (1987) notes, the critical period hypothesis (CPH) for phonology is an *a priori* assumption about the basis of adult-child differences rather than a testable hypothesis. Flege warns that accepting the critical period hypothesis might result in obstruction of the development of specific hypotheses that lend themselves to empirical investigation.

The present study seeks to examine the viability of a critical/sensitive period in the domain of L2 phonology based on an Optimality Theoretic framework (OT) (Prince & Smolensky, 1993; McCarthy & Prince, 1993). In this sense, we join Hancin-Bhatt (1997), Hancin-Bhatt and Bhatt (1997) and Escudero and Boersma (2004), *inter alia*, in examining L2 acquisition from an OT perspective. We will show that adults exposed to a second language after the age of 12, the supposed cut-off for a critical period, are able to acquire/establish new phonemic contrasts/categories and to access universal phonological constraints that govern output. We claim that they do so by employing the same learning algorithms that allow children to converge on the adult constraint ranking of their language by reranking markedness constraints–which compel alternations in the output to avoid marked structures–and faithfulness constraints–which militate against input-output change–based on the input. We offer an account of the acquisition of the velar nasal /ŋ/ as well as the distribution of coda nasals in English by L2 learners of English/L1 Spanish. In most dialects of Spanish (disregarding assimilation contexts), word-final coda nasals neutralize to the unmarked coronal place of articulation (Piñeros, 2007). Piñeros argues that the markedness constraint PLACE HIERARCHY outranks the input-output faithfulness constraint MAX(Place). We will argue that the L1 Spanish speaker must rerank the dominant PLACE HIERARCHY constraint below MAX(Place) such that faithfulness dominates markedness, thus allowing coda nasal contrasts to surface. The question then becomes: can phonological constraints be reranked on the basis of target input? Does a critical period for phonology predict that this should be impossible? A strict interpretation of the CPH implies just that.

To test this prediction, we report on two tasks from a four-part study of 24 advanced L1 speakers of Spanish acquiring L2 English. Results from AX discrimination and production tasks indicate that acquisition of /ŋ/ and subsequent constraint reranking in the phonological domain (at least for this particular phenomenon) is possible. Individual results, however, demonstrate that the proper constraint ranking is subject to some degree of variability unattested in native speakers of English. We will argue

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that individual differences reflecting degrees of variability are accounted for under the *Constraint Fluctuation Hypothesis* (CFH), which accounts for constraint fluctuation influences from the L1. However, access to the same mechanisms that guide L1 acquisition and are provided by Universal Grammar must be implicated to explain the acquisition of the new phonemic contrast /ŋ/ as well as the constraint ranking that results in the target output observed in the majority of cases for all learners.

2. Coda Nasals in English and Spanish

There is a phonemic distinction between three nasal consonants in both Spanish and English; however, the languages differ in both the inventory and distribution of these phonemes. All dialects of Spanish contrast /m/, /n/ and /ɲ/ in syllable onset position.

(1)	a. /kama/	b. /kana/	c. /kaɲa/
	cama	*cana*	*caña*
	'bed'	'gray hair'	'cane'

The contrast between nasals is neutralized in coda position, where, with the exception of assimilation contexts, only alveolar [n] is realized. This can been observed in alternations such as those in (2).

(2) a. *Adán* [a.ð̪a**n**] 'Adam' ~ *adamita* [a.ð̪a.**m**i.t̪a] 'Adamite, descendent of Adam'[1]
b. *desdén* [d̪ez.ð̪e**n**] 'disdain' ~ *desdeñoso* [d̪ez.ð̪e.**ɲ**o.so] 'disdainful'

Piñeros (2007) utilizes an Optimality Theoretic framework to analyze neutralization of coda nasals in Spanish as the result of the MARKEDNESS constraint PLACE HIERARCHY dominating the FAITHFULNESS constraint MAX(Place). PLACE HIERARCHY follows from the notion that coronal is the most economic place of articulation and dorsal is the most costly (Prince & Smolensky, 1993; DeLacy, 2002). Universally, coronal is the least marked place of articulation due to the flexibility of the tongue apex and blade (i.e., corona). In contrast, the tongue body is relatively immobile, making dorsal articulations the least economical. Labial articulations, which involve raising the jaw and bringing the lower lip to the upper lip, lie between dorsal and coronal in terms of markedness.

(3) PLACE HIERARCHY
*DORSAL » *LABIAL » *CORONAL

Neutralization of coda nasals in Spanish can be accounted for by the ranking MAX$^{\text{Onset}}$(Place), HAVEPLACE » PLACE HIERARCHY » MAX(Place). The domination of PLACE HIERARCHY (3) over the FAITHFULNESS constraint MAX(Place) (4) disallows candidates with dorsal or labial places of articulation (Piñeros, 2007). Because the dominant MAX$^{\text{Onset}}$(Place) outranks PLACE HIERARCHY, nasals in the onset are realized faithfully (e.g., *a.da.**m**i.ta* and *des.de.**ñ**o.so* from (2)). In addition, coda nasals may not remain placeless, as in candidate (7a), due to the constraint HAVEPLACE (6). This constraint ranking is shown in tableau (7).

(4) MAX(Place): The place features of input segments must be preserved in output correspondents (see Lombardi, 2001, for MAX(Laryngeal)).

(5) MAX$^{\text{Onset}}$(Place): Onset segments preserve the place features of their input correspondents (following Beckman, 1999, and Lombardi, 2001).

(6) HAVEPLACE: All segments must have place features (following Piñeros, 2007).

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[1] [ð̪] represents the dental approximant that results from intervocalic spirantization of dental /d̪/ in Spanish.

(7) Coda nasal neutralization (Piñeros, 2007, p. 156)

/ad̪am/	Max^Ons (Place)	Have Place	Place Hierarchy†			Max (Place)
			* Dorsal	* Labial	*Coronal	
a. [a.ð̪aɴ]		*!				*
b. [a.ð̪aɲ]			*!		*	*
c. [a.ð̪aŋ]			*!			*
d. [a.ð̪am]				*!		
☞ e. [a.ð̪an]					*	*

†Violations are evaluated only with respect to the nasal segment.

English also has three nasal phonemes, /m/, /n/, /ŋ/; however, unlike Spanish, all three phonemes contrast only in coda position.[2]

(8) a. /kɪm/ 'Kim' b. /kɪn/ 'kin' c. /kɪŋ/ 'king'

Renaud (2009) accounts for the maintenance of nasal place distinctions in English codas by ranking Max(Place) above Place Hierarchy (again ignoring assimilation contexts). Thus, nasal place articulations in English must be faithful to the input at the expense of satisfying Place Hierarchy. This is exemplified in (9).

(9) i. Max^Onset(Place) » Have Place » Max(Place) » Place Hierarchy
ii. English constraint ranking accounting for coda nasal contrast (Renaud, 2009)

/kɪŋ/	Max^Ons (Place)	Have Place	Max (Place)	Place Hierarchy†		
				* Dorsal	* Labial	* Coronal
a. [kʰĩɴ]		*!	*			
☞ b. [kʰĩŋ]				*		
c. [kʰĩm]			*!		*	
d. [kʰĩn]			*!			*

†Violations are evaluated only with respect to the nasal segment.

In order to converge on a native-like grammar, L1 Spanish speakers acquiring L2 English must do two things: first, they must acquire a novel representation and distribution for the phoneme /ŋ/,[3] which appears only allophonically in assimilation contexts in Spanish; and second, they must "unlearn" coda neutralization to allow nasal place distinctions in coda position. Specifically, they must modify the constraint hierarchy of their L1 Spanish grammar by reranking Max(Place) above Place Hierarchy to converge on a native-like English constraint ranking (10).

(10) Max^Onset(Place) » Have Place » Place Hierarchy » Max(Place)

We claim that L2 learners make use of the same universal mechanisms for L1 contraint ranking

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[2] With regards to word-medial velar nasals, as in *singer* or *dinger*, we would like to point out that the distribution is limited to morphologically complex forms, which is explained by Output to Output (OO) correspondence with morphologically related base forms, such as *sing* and *ding* (cf., morphologically simple *finger*).

[3] The ability to acquire novel phonemic representations is not the central focus of the current study; however, we will address this later in the discussion. Boomershine, Hall, Hume, and Johnson (2008) present a detailed discussion on the interaction between allophony and perception in second language acquisition.

(whatever they turn out to be) to rerank constraints for the L2. However, before reranking may occur, the L2 learner must first realize (perhaps unconsciously) that there is a conflict between the L2 input and their current L1 constraint hierarchy, which will in turn lead them to rerank the appropriate constraints. In this sense, L2 phonological grammars are initially built using the L1 phonological grammar, but after the initial stages, as modifications to the 'transferred L1 blueprint' occur, the L2 phonological grammar becomes distinguishably different from the L1. In this sense, from the earliest stage of the interlanguage grammar through the last stage of development, the L2 phonological grammar is a separate grammar from the L1. Crucially, the learner must accurately perceive phonemic distinctions in the input, in this case, the contrast between /m/, /n/ and /ŋ/ in coda position. This claim will be discussed with regards to our data in section 5, following a brief explanation of the methodology and results in the next two sections.

3. Methodology

There were a total of 49 subjects belonging to one of two groups: 24 L1 Spanish learners of L2 English (16 females, 8 males, ages 21-62, mean age 36) living in the United States and 25 native English controls (16 females, 9 males, ages 19-55, mean age 29). Although an effort was made to control for dialectal variation in Spanish, especially with regards to the distribution of coda nasals, the Spanish speakers did come from different countries (Mexico *n*=11, Columbia *n*=3, Spain *n*=4, Argentina *n*=2, Peru *n*=2, Chile *n*=1, and El Salvador *n*=1). All L2 English participants reported arriving in the U.S. after the age of twelve. In addition, the L2 learners had lived in the United States from 3-30 years (mean 13 years) and had spoken English for 4-41 years (mean 15 years). No participant reported history of hearing or learning impairment.

The experimental methodology consisted of four tasks: an AX discrimination task, a picture identification task, a word identification task, and a production task. The presentation order of the four tasks was counterbalanced across participants. Stimuli for tasks 1 through 3 were natural speech tokens recorded by a native speaker of English from the Midwest, United States, consisting of monosyllabic words. For reasons of space, we only report on the AX discrimination (Task 1) and the oral production (Task 4) tasks in what follows.

Task 1 was an AX discrimination task administered via Praat. The total 18 experimental tokens (i.e., nine minimal pairs) consisted of six tokens per each of three conditions: final [m] ~ [n] (e.g., *scream*, *screen*), final [m] ~ [ŋ] (e.g., *game*, *gang*) and final [n] ~ [ŋ] (e.g., *sun*, *sung*). See the Appendix for a list of all stimuli. Vowel length and total length of the utterance were maintained constant for all experimental stimuli. In addition to the experimental tokens, there were 26 fillers (i.e., 13 minimal pairs) that differed in other phonological aspects such as vowel quality (e.g., *dead*, *dad*), final consonant voicing (e.g., *leaf*, *leave*), and consonant identity (e.g., *mud, mug*). Participants listened to pairs of words with an inter-stimulus interval (ISI) of 700 milliseconds and were asked to indicate whether the two words were the *same*, *different* or whether they were *unsure* ('unsure' was considered an incorrect response).

Task 4 was an oral production task that consisted of 28 pairs of declarative sentences in which the stimuli were the last word of the sentence. Declarative sentences were used in order to avoid possible prosodic differences in tokens and also to avoid assimilation environments for Spanish speakers. There were 18 experimental tokens across three final-nasal conditions (final /m/, final /n/, final /ŋ/) and 10 fillers. In order to distract the participants from the true nature of the task, they were instructed to read a pair of very similar sentences, one of which was grammatically incorrect in English and decide which sentence was more natural. After choosing which sentence they thought was more natural in English, they read that sentence aloud. As all sentence pairs ended in the same word, it was irrelevant which sentence was chosen. Sentences (11) and (12) are examples of test stimuli and fillers, respectively (see the Appendix for a list of all stimuli). The production data were examined impressionistically (i.e., by ear) and coded by two judges, and in the rare case that the judges disagreed, spectrographic analyses were performed.

(11) a. **Him phone in the kitchen rang*.
b. *His phone in the kitchen rang*. (subject chooses *b* and reads aloud)

(12) a. *The airport charges a big fee for bags*. (subject chooses *a* and reads aloud)
b. **The airport charge a big fee for bags*.

As previously stated, for the sake of brevity, we will only report on tasks 1 (AX discrimination) and 4 (oral production) in what follows; however, we will reference tasks 2 and 3 for a more fine-grained discussion of some of the results.

4. Results

As seen in Figure 1, the repeated measures ANOVA revealed that both group ($F(1, 47) = 17.931$; $p < 0.001$) and condition ($F(2, 94) = 4.153$; $p = 0.019$) were found to be significantly different in discriminating minimal pairs. A Šidak *post hoc* test determined that condition two (m ~ ŋ) differed significantly from condition three (n ~ ŋ): $p = 0.009$. There is no significant interaction between group and condition ($F(2, 94) = 1.737$; $p = 0.182$). An item analysis revealed that no particular pair within any condition was significantly different than any other pair within that condition for either group, with the exception of the pair *swim~swing*, which was significantly easier for the L2 group only ($p = 0.007$ compared to *game~gang*; $p = 0.015$ compared to *ham~hang*). This is likely due to the fact that [ɪ] is raised before the velar nasal, thereby providing extra acoustic cues that L2 learners could have used to discriminate *swim* and *swing*. In fact, there is a slight raising effect for all of the front vowels before the velar nasal in English, but that did not seem to aid in the perception of other pairs (such as *ham~hang*). Unfortunately, it is impossible to control for all acoustic cues when using natural speech stimuli; yet, at the same time, the result of using natural speech tokens over synthetic tokens is that natural tokens more accurately reflect real-life conditions under which these sounds are perceived.

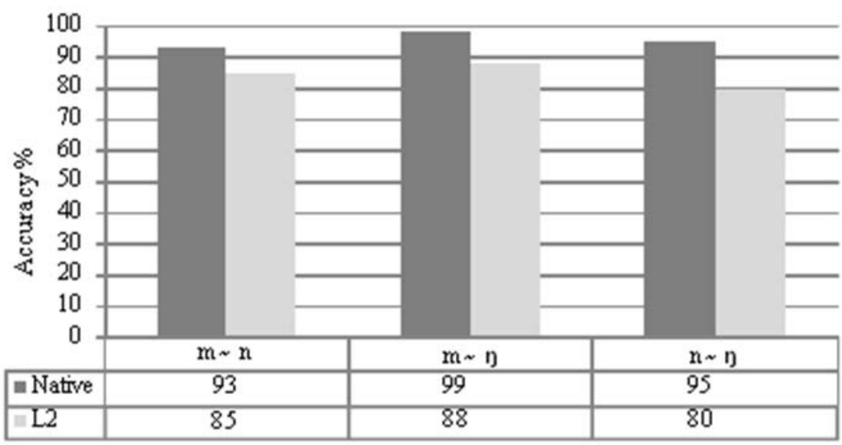


Figure 1. Accuracy by group on task 1: discrimination

Although as a whole, group was significant, the results of individual analyses reveal that 15 of the 24 L2 participants (or 63%) performed within the native range over all three conditions: 67%, 83% and 75% (percent correct out of six) for conditions 1 through 3, respectively. If the ability to discriminate minimal pairs is indicative of having formed underlying phonemic representations for the corresponding sounds, we argue that the following participants (highlighted in boldface type) had accurately constructed native-like input representations at least for the items tested (i.e., their lexicon contains items with /m/, /n/ and /ŋ/ in final position). Thus, non-native-like production by these same individuals with respect to these lexical items implies the application of an L1 Spanish hierarchy at the moment of OT evaluation (i.e., the moment of utterance), especially if what is produced conforms to what a Spanish grammar requires; that is, the production of a word-final coronal nasal.

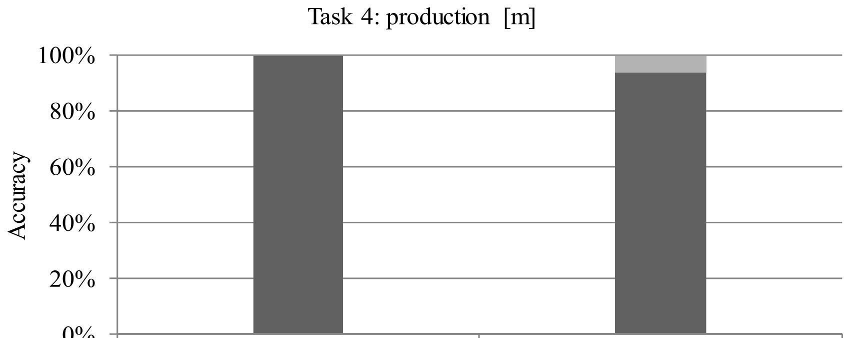
Table 1
Individual L2 learner results for task 1

L2	m ~ n	m ~ ŋ	n ~ ŋ
A	**100**	**100**	**100**
B	**100**	**100**	**83**
C	**83**	**100**	**100**
D	**83**	**100**	**83**
E	**83**	**100**	**100**
F	**67**	**100**	**100**
G	**83**	**100**	**100**
H	67	83	50
I	67	67	17
J	67	83	50
K	**67**	**100**	**83**
L	75	75	75
M	**100**	**92**	**83**
N	**100**	**92**	**100**
O	75	67	42
P	92	75	58
Q	**100**	**92**	**83**
R	**75**	**83**	**83**
S	83	75	92
T	**92**	**92**	**92**
U	**100**	**92**	**100**
V	100	75	75
W	100	75	83
X	**83**	**92**	**83**

Table 2
Individual native speaker results for task 1

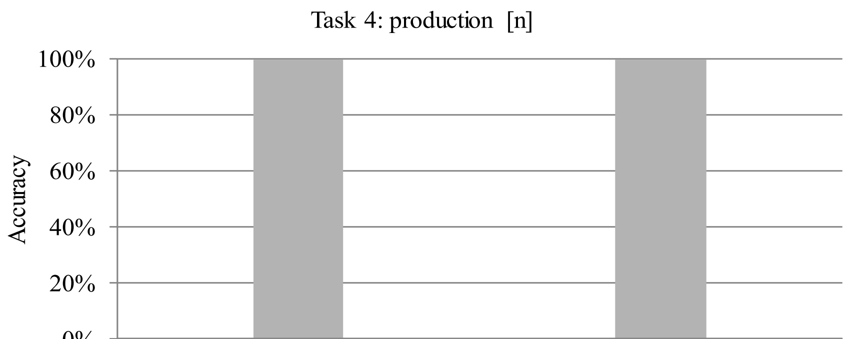
Nat	m ~ n	m ~ ŋ	n ~ ŋ
AA	83	100	100
BB	67	100	100
CC	100	83	100
DD	100	100	100
EE	83	100	100
FF	100	100	100
GG	83	100	100
HH	100	100	100
II	83	100	100
JJ	100	100	100
KK	100	100	100
LL	100	100	83
MM	100	100	92
NN	100	100	100
OO	100	100	100
PP	100	100	83
QQ	92	100	100
RR	100	92	100
SS	67	100	75
TT	100	92	92
UU	92	100	100
VV	92	100	83
WW	92	100	92
XX	92	100	100
YY	100	100	83

Figures 2 through 4 show the number of times (percentage out of six) a test item was pronounced accurately for each condition in the production task. Not surprisingly, every instance of /n/ in condition 2 (Figure 3) was accurately pronounced as the coronal nasal [n]. Where there were errors in the other conditions (Figures 2 and 4), they were uniformly unidirectional: errors in condition 1–/m/–were consistently produced as [n], as were errors in condition 3–/ŋ/–a fact which we argue demonstrates that these speakers may rely on their Spanish OT hierarchy for any given output production.



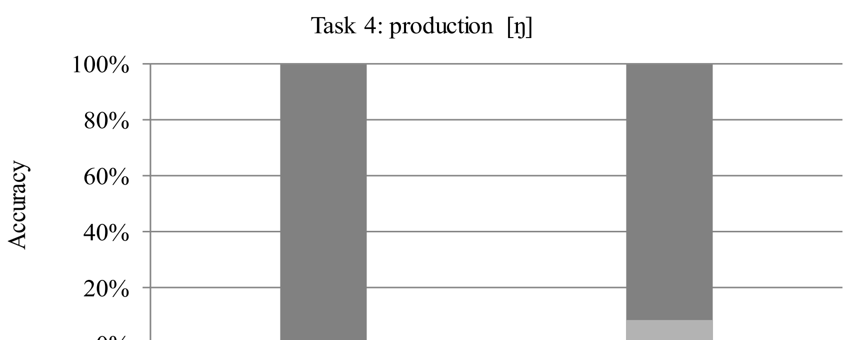
	Native	L2
[ŋ]	0	0
[n]	0	6
[m]	100	94

Figure 2. Production of [m]: Native English speakers versus L1 Spanish learners (group means)



	Native	L2
[ŋ]	0	0
[n]	100	100
[m]	0	0

Figure 3. Production of [n]: Native English speakers versus L1 Spanish learners (group means)



	Native	L2
[ŋ] (+stop)	100	92
[n]	0	8
[m]	0	0

Figure 4. Production of [ŋ]: Native English speakers versus L1 Spanish learners (group means)

Statistical analyses show that both group ($F(1, 47) = 10.706$; $p = 0.002$) and condition ($F(2, 94) = 3.246$; $p = 0.043$) were significant. There was an interaction for group by condition ($F(2, 94) = 3.246$; $p = 0.043$); the *post hoc* test revealed that both conditions 1 (m~n) and 3 (n~ ŋ) were significant (p = 0.019 and 0.18, respectively).[4]

It is worth mentioning that a homorganic nasal + stop consonant pronunciation ([ŋɡ] or [ŋk]) for the phoneme /ŋ/ was attested in both L2 participants (15% of productions) as well as native speakers of English (13%) in Houston. Although nonstandard, these are included in Figure 4 as "correct" realizations of /ŋ/ since they were attested in the speech of the native control group at nearly the same rate. Furthermore, of the two participant groups – those tested in Iowa and those in Houston – the only participants – native and L2 English alike – who demonstrated such pronunciations were found in the Houston group. We thus conclude that these productions are the results of dialectal variation, and the Houston L2 participants are simply acquiring the (non-standard) dialect to which they are exposed.[5]

5. Discussion

The results of Task 1 indicate that 15 out of 24 L2 learners demonstrated native-like perception of the distinction between /m/, /n/, and /ŋ/ in coda position. In addition, production data suggest that for any given utterance, the L2 learners were able to instantiate an English-like constraint ranking 95% of the time (412/432 utterances). It is important to note that the other 5% of the time (20/432 utterances), they seem to be relying on a Spanish-like constraint ranking, as evidenced by the directionality of errors (i.e., all erroneous utterances were produced with [n]).

As mentioned in section 2, it was expected that L2 learners would demonstrate accurate perception of /ŋ/ before they reached native-like levels of producing the three nasals in coda position, since it is critically the accurate perception of target language input that triggers realization of disparate L1 and L2 constraint rankings, which subsequently leads to L2 constraint reranking. As Table 3 shows, while this is not absolute, there is a clear trend in this direction.

Table 3

Results summary for tasks 1 and 4[†]

	A	B	C	D	E	F	G	H	I	J	K	L
Task 1												
Task 4												

	M	N	O	P	Q	R	S	T	U	V	W	X
Task 1												
Task 4												

[†]Shading indicates that an individual performed within the native range. L2 participants J, L and P performed within the native range in task 4 production, but not in task 1 perception, seemingly contra the predictions of the CFH.

As demonstrated in Table 3, L2 participants H, I, O, S, V and W (6 out of 24; 25%) did not perform within the native range for either task 1 or task 4. Participants B, F, G, K and Q (5 out of 24;

[4] A reviewer notes that a comparison between native speakers' production and perception from Figure 1 seems to suggest that the 'perception precedes production' claim does not hold, since the native speakers fared worse in perception than production. This is, however, a developmental claim that is not contradicted by our native speaker data. The native control group fared worse on the perception task not because production precedes perception, but rather because the acoustic cues to place in nasal segments are relatively weak. Thus, 100% accuracy in perception is not guaranteed. With respect to the L2 group, the developmental prediction was borne out.

[5] As one reviewer points out, further support for characterizing [ŋ] and [ŋ]+stop as the same follows from the fact that the audible release could also be an artifact of the phonetic release of the velar nasal, which is optional in English and, based on our results, is relatively common in the Houston area.

21%) demonstrated native-like perception, but performed outside native parameters for production. Participants A, C, D, E, M, N, R, T, U and X (10 out of 24; 42%) can be said to have reached native-like perception and production. These three groups (cumulatively, 21 out of 24; 88%) fall within what we would predict. Remaining unaccounted for are participants J, L and P (3 out of 24; 13%).

With respect to L and P, both performed within the native range in one of the two other perception tasks not reported here for reasons of space. Thus, they might better be classified as members of a group who performed within native ranges in one out of three perception tasks in addition to the production task. In this sense, their behavior is keeping with our predictions. Such an explanation is unsatisfactory for participant J who was not within the native range for any of the three perception tasks.

A closer look at J's individual performance reveals that the most problematic condition in all perception tasks is the /ŋ/ condition, which is the one phoneme missing from his/her native grammar. In this sense, J can be described as fluctuating between the L1 and L2 hierarchy in any given evaluation.

Table 4
Participant J

Task 1			Task 2			Task 3		
m ~ n	m ~ ŋ	n ~ ŋ	m	n	ŋ	m	n	ŋ
67	83	50	67	83	67	100	83	17

To account for this and the other data presented thus far, we propose that some L2 input/output differences might be better understood as an L1 preemption problem. We propose that these results can be accounted for under the *Constraint Fluctuation Hypothesis* (CFH), which claims that, while L2 learners rerank constraints in the course of L2 phonological development and, in doing so, wind up with an L2 grammar that is convergent on the target constraint hierarchy, they may also continue to rely on their L1 ranking, which results in the variability observed. In this sense, while the L2 learner may have a native-like L2 constraint ranking, this does not mean that they never access their native L1 ranking. We need to be very clear about what we mean by a few notions here to justify the CFH. First, we need to highlight a basic fact about the learners we are dealing with. L2 acquisition is a specific case of bilingualism. Like all bilinguals, L2 learners by definition (especially successful ones as we have tested) have access to multiple mental grammars. We take the evidence of our tasks to support the proposal that these learners have an L2 phonological grammar for English that, at this point in development, at least, is a separate, independent grammar from their L1 Spanish phonological grammar. Having acquired the target constraint rerankings for L2 English, however, does not mean that, when dealing with English for perception or production, the Spanish phonological grammar is not simultaneously activated. One of the formidable tasks for L2 learners, bilinguals more generally, is suppressing interference from other mental grammars as they deal with input and output of the language at hand for any give task (experimental or in real time use). The aforementioned is covered extensively in psycholinguistic research, under the label of inhibitory control (see, e.g., Green, 1998). While it is thus theoretically possible that influence would be bidirectional, it is an observable fact that influences of additional mental grammars tend to lean towards an L1 influence on the L2. The CFH capitalizes on issues related to inhibitory control to explain why, at the level of output production and perhaps even at the level of perception, variability is manifested even with the most proficient L2 learners. Essentially, the CFH claims that L2 learners acquire the constraint rankings of the target language through development in much the same way as children (although the tasks are different for development if the L2 initial state for phonology is the transferred L1 phonological system), but that the simultaneously activated L1 system with different constraint rankings will sometimes not be inhibited, thus giving rise to variability. The general idea is that the more advanced an L2 learner truly is, the less likely L1 influence becomes since they have greater inhibitory control, a factor that most likely aided in making them as advanced as they were. To be clear then, the CFH maintains that L2 learners at very advanced levels have truly independent phonological grammars, one for the L1 and one for the L2, that are target(-like) in mental representation, but for reasons of simultaneous activation of both grammars and limitations on inhibitory control, some L1-influenced optionality in perception and especially production might occur. In this way, the CFH is able to account for individuals who experimentally do not show L1 influences and those that do show some L1 influences, but largely speaking otherwise show strong evidence of target convergence on the target phonological grammar.

We should also be clear, as it relates to the CFH, about the levels at which we envision OT constraints apply; that is, to formal aspects of phonological representations only or to the domain of phonetic implementation. First and foremost, we take the constraints to be formal descriptions of the underlying mental representation, which, ideally relates to perception as well in the sense that the constraints are implemented to parse input. The CFH makes full use of this understanding of constraint rankings. Thus, the CFH proposes that the constraint rankings accessed shape perception and production. As a result, L2 variability in phonological perception or production at very high levels of L2 proficiency (when strong evidence exists) that otherwise shows target knowledge is understood as a byproduct of bilingualism; that is, the presence of a competing grammar (the L1 grammar) in the mind that is never fully deactivated. To anchor such claims, let us recall that the learners in this study did extremely well in general. Should we otherwise dismiss their ‘relatively good’ performance as a group and even as individuals, or, alternatively, should we endeavor to explain why variability exists even to such a small degree as our experiments uncovered? Why should such variability almost always reflect L1 influence? It seems that the CFH is a tenable proposal to explain all the observations discussed here. Future research that is able to tease apart and refine its predictions is warranted.

6. Conclusion

In this study, we have set out to move beyond observations of holistic failure in the domain of L2 acquisition of phonology and focus empirical testing on possible success in domains that a critical period approach would consider unlikely, if not impossible (i.e., reranking constraints). Given the results of the empirical research presented here, we reject a critical period for the development of L2 phonology and offer the *Constraint Fluctuation Hypothesis* to account for (at least some of) the observable differences in child and adult acquisition of phonology.

Appendix

Task 1 stimuli

Condition 1 (m~n): gum/gun, ma’am/man, scream/screen
Condition 2 (m~ŋ): game/gang, ham/hang, swim/swing
Condition 3 (n~ŋ): fan/fang, sun/sung, win/wing

Task 4 stimuli

a. Him phone in the kitchen rang.
b. His phone in the kitchen rang.

a. The mother telled the kids to play in the sun.
b. The mother told the kids to play in the sun.

a. The millionaire’s money will go to his next of kin.
b. The millionaire money will go to his next of kin.

a. Her called Sue on the phone.
b. She called Sue on the phone.

a. The baker with the chocolate asks me if I want some.
b. The baker with the chocolate ask me if I want some.

a. His juggled for the king.
b. He juggled for the king.

a. There is nothing to lose, everything to gain.
b. There are nothing to lose, everything to gain.

a. Everyday the boy visits his pet ram.
b. Everyday the boy visit his pet ram.

a. Him baseball cap is green.
b. His baseball cap is green.

a. At the concert, my favorite songs was sung.
b. At the concert, my favorite song was sung.

a. Every child has a favorite game.
b. Every children has a favorite game.

a. After class I always go for a long run.
b. After class I always goes for a long run.

a. Thankfully my neighborhood don't have a gang.
b. Thankfully my neighborhood doesn't have a gang.

a. She helps the planet by recycling tin.
b. She help the planet by recycling tin.

a. Jill's new best friend are Kim.
b. Jill's new best friend is Kim.

a. John favorite drink is rum.
b. John's favorite drink is rum.

a. Frank's new neighbor is Tim.
b. Frank new neighbor is Tim.

a. Him told me that she ran.
b. He told me that she ran.

a. My ears were hurt by the bell's ting.
b. My ears was hurt by the bell's ting.

a. The ladder is missing a rung.
b. The ladder are missing a rung.

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