An OT Analysis on Epentheses Phenomenon of Chinese College Students' English Pronunciation of Plosives in the Word Final Position

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1.INTRODUCTION

An epenthesis in phonology is interpreted as the addition of one or two phonemes that do not exist in the original word for the convenience of pronunciation, which is commonplace in English pronunciation, for instance, when speaking strength, it is commonly pronounced as /streŋkθ/ rather than /streŋθ/, and when speaking Asia and Africa, a consonant / r / will be inserted after the word "Asia",it is usually pronounced as /ˈeɪʒər/ instead of /ˈeɪʒə/. It is extremely pertinent, and in accordance with the English habit of pronunciation, that the epentheses make the

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successive sounds light and natural. Notwithstanding, Second language (L2) learners in China are always conveniently influenced by their native language (L1) phonology and insert some redundant sounds after consonants, for example, plug/plʌ g/is falsely pronounced/plʌ g ə /, and hope/həʊp/was inaccurately read as /həʊpu /.

Selinker(1972) interprets by interlanguage theory that the procedure of learning is learners gradually alter the constraints of L1 to a position consistent with L2,the interlanguage grammars between L1 and L2 arise in this learning process, and L1 grammar is the onset of language learning. Archibald(1997,1998), Ozcelik(2017) publicize that although interlanguage and rhythm parameters can be established by learners according to the requirements of L2 phonetic system, some rhythm parameters of L1 still will be transferred into interlanguage grammars, which engender pronunciation errors. Broselow (1988) and Broselow& Park (1995) detect that the epentheses of English syllable structure generated by Arabic L2 learners and Korean L2 learners, which indicates the epentheses among Chinese L2 learners may be developed by the distinction between the syllable structure of English and Mandarin since approximately all Mandarin syllables end with vowels except for a consonant nasal /n/ or /ŋ/,and vowels have a dominating position in Mandarin, while most English words,

on the contrary, come with complex syllable margins.

The acquisition of complex coda has attracted increasing attention in recent years. Tench (2003) reveals in an experiment on the perceptual acquisition of English segments by Korean English learners that the perceptual accuracy of consonants is about 80%, but that of plosive/b/is only 50%, and that the perceptual accuracy of consonants at the coda position of a word is considerably lower than those at the beginning and middle. Masuda & Arail (2008) investigate the acquisition of English consonant coda in Japan and conclude that the perceptual accuracy was 90%. The study of phonetic epentheses generated by Chinese English learners, which focuses on the acquisition of complex syllable endings, is mainly divided into two aspects: First, numerous researchers have empirically investigated the phenomenon of phonetic epentheses by English learners using corpus linguistics research methods. The results show that epentheses occur mostly at the end of words, and consonant epentheses are prevailing (Feng, 2005) (Wang, 2009). Fan (2008), Meng(2012), Li (2013) and Cui (2019) conduct empirical studies on the acquisition of complex consonant clusters by Chinese English learners in Beijing dialect, Miao nationality dialect, Cantonese and Hebei dialect, respectively. This paper, based on empirical research with Mandarin as L1 and English as L2, collects the phonetic data from 38 language learners and analyzes the phonetic

eptheses of complex syllable endings of Chinese English learners through Optimality Theory with the help of Praat software, hoping to fill the gap in this field and help teachers better understand the interlanguage grammar existing in Chinese English learners. The present study aims to answer the following questions:

(1) Do English learners in Chinese universities experience the phenomenon of epenthesis when pronouncing the plosive at the end of a syllable? What are they if there is an epenthesis?

(2) What are the characteristics or rules of these eptheses?

(3) Will this phenomenon decrease as the language level of the learner increases?

(4) How to analyze this phenomenon with Optimality Theory?

In this paper, Optimality (OT) Theory (Prince&Smolensky, 1993) is applied to determine whether Mandarin interferes in the pronunciation of English syllables. A comparison between English and Mandarin phonology, particularly in terms of the consonant system and syllable structure, is provided in Section 2. The design of the experiment is reported in Section 3, the results of the experimental observations are presented in Section 4, and a discussion of the results is provided in Section 5. Then, the OT theory is

used in Section 6 to analyze the phenomenon of epentheses when Chinese speakers pronounce the plosive sound at the end of a syllable. Finally, some specific conclusions and teaching suggestions are put forward in Section 7.

2. BASES OF MANDARIN AND ENGLISH PHONOLOGY

Chinese speakers have great difficulty in pronouncing the final consonant of a syllable, due to the difference in syllable structure between English and Mandarin, which is particularly pronounced and typical in the case of a syllable with a plosive in the final position. Hence, this section firstly compares the consonant systems and structures of Mandarin and English, which are relevant for this study.

2.1 English and Mandarin Consonant System

Phones are divided into vowels and consonants according to the characteristics of pronunciation, hearing and acoustic in phonology, and English and Mandarin are identical in the writing of some vowels and consonants, but their timbre are different because the airflow will be hindered by various degrees in the resonance cavity to produce different timbre in the process of pronunciation.

2.1.1 English Consonant System

Gimson 's pronunciation of English (Cruttenden, 2001,29-30) specifies that there are 24 consonants in English, which can be divided into the following 8 categories according to the pronunciation position (see table 1 horizontal axis) and the following 6 categories according to the pronunciation method (see table 1 vertical axis).

Table 1 English Consonants (based on Alan Cruttenden, 2001)

		bilabial	labio-dental	inter-dental	alveolar	palatal	velar	glottal
plosive	+vcd	b			d		g	
	-vcd	p			t		k	
fricative	+vcd		v	ð	z	ʒ		h
	-vcd		f	θ	s	ʃ		
affricate	+vcd					tʃ		
	-vcd					dʒ		
nasal	+vcd	m			n		ŋ	
liquid/retroflex	+vcd				l/r			
glide	+vcd					J	w	

2.1.2 Mandarin Consonant System

Wang Lijia and Lin Tao (1992, 76-79) spell out in the book "Phonetics Course" that there are 22 consonants in Mandarin, which can be divided into 7 categories according to the pronunciation position (see table 2 horizontal axis),

according to the pronunciation method can be divided into 6 categories (see table 2 vertical axis).

Table 2 Mandarin Consonants (based on Wang Lijia& Lin Tao ,1992)

|		labial	dental-alveolar	alveo-palatal	palatal	retroflex	velar
plosive	-asp	p	t				k
	+asp	p^h	t^h				k^h
fricative		f	s	ɕ		ʂ	x
affricate	-asp		ts	tɕ		tʂ	
	+asp		ts^h	$tɕ^h$		$tʂ^h$	
nasal		m	n				ŋ
liquid			l				
glide					j ɥ		w

2.2 English and Mandarin syllable structure

A syllable is the smallest segment of a phoneme which must be combined into some unit in order to be naturally felt in the actual communication of language. It is regularly divided into onset and rhyme, and rhyme into nucleus and coda. In the general syllable structure, vowels are used as nuclei and in the core position, while consonants are placed in front or behind vowels and are affixed to vowels. There are four basic types of syllables consisting of vowels and consonants: (1) V (2) CV (3) VC (4) CVC

2.2.1 English syllable structure

The syllable structure of English can be summarized as from V to (C)(C)(C) V (C)(C)(C)(C) in figure 1 below.
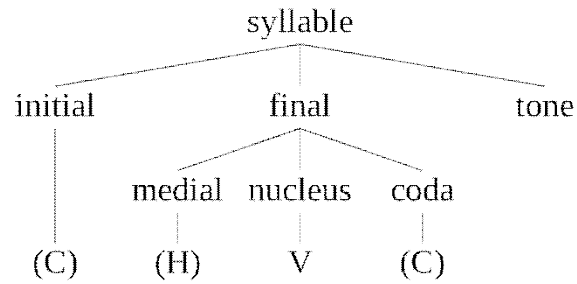
Figure 1 English syllable structure
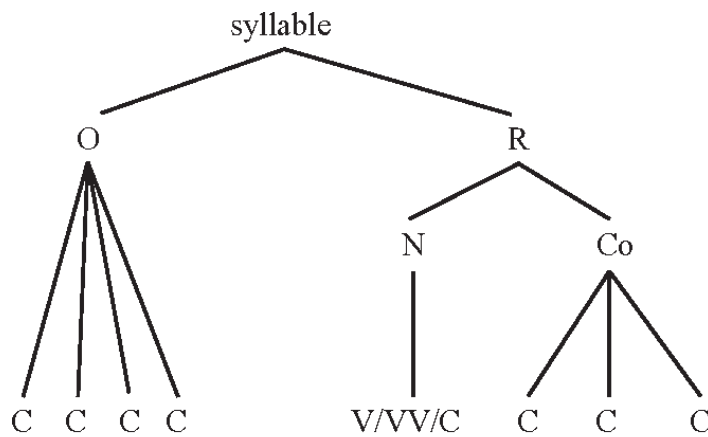
2.2.2 Mandarin syllable structure

Mandarin has largely affluent vowel clusters but consonant clusters are not allowed to obtain, which means V can be boosted to VV or VVV but C can not be broadened to CC, CCC or CCCC. Thus, the syllable structure of Mandarin can be summarized as from V to (C)(V) V (V) (N), "N" means only nasal consonants authorized, which can be seen in figure 2 below.

Figure 2 Mandarin syllable structure

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                        syllable
              _____|_____
          initial         final          tone
             |          ____|____
             |       medial nucleus coda
             |         |      |      |
            (C)       (H)     V     (C)
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2.2.3 A contrastive Analysis of Mandarin and English Syllable Structure

Both English and Mandarin syllable structures have V, CV, VC and CVC, and the consonants at the end of English syllables can be extended to maximum CCCC, while the consonants at the end of Mandarin syllables are not approved but only one nasal consonants (N) -n. However, English is a polysyllabic language, where a word can be composed of several syllables, but a Chinese word can only have one syllable.

3. RESEARCH DESIGN

This experiment focuses on the pronunciation of the plosives in the final position.

3.1 Participants

The subjects of the experiment are 36 students selected from the second grade who have not previously participated in professional phonics training, which will ensure that the results of the survey can sufficiently characterize some general aspects of Chinese L2 learners in universities. 36 participants (see Appendix 2) are divided into two language level groups, 18 students who took the CET-4 but failed the test are classified as group 1, 18 students who have already passed the CET-4 are classified as group 2.

3.2 Experimental materials

There are six plosives: / b /, / p /, / t /, / d /, / k /, / g / and the consonant clusters in which they occur include VC, VCC, VCCC and VCCCC. The materials used in the experiment are designed by the author, and selected from the textbook "New Horizon English Course-Listerning and Speaking Version 1" (Zheng&Hu, 2017) that students have learned, which consists of 18 words, covering 3 groups of words with polsive /b/, /p/, /t/, /d/, /k/, /g/ and VC, VCC, VCCC syllable structures(see Appendix 3).The actual conditions of the speaker 's pronunciation of plosive in the word coda position can be thoroughly mastered by reading these materials.

3.3 Data collection

a. The voice materials of Chinese L2 English speakers in this experiment are collected through mobile online survey platform wenjuan.com (Shanghai Zhongyan, 2008). Background information, word list and reading instruction are written in the first questionnaire (see Appendix 1), and the speakers are required to be familiar with the vocabulary in survey before recording (Access to dictionaries is allowed), read the words aloud at a medium speed in the quiet room, and submit the voices by mobile wenjuan.com after completing the recording with the mobile phone recording function software. The questionnaire is designed to be submitted within 10 minutes and only once to avoid self-correcting pronunciations by speakers.

b. All recording formats are uniformly converted to MP3 format by conversion platform aconvert.com (Aconvert, 2000) according to the original bit rate and sampling rate after collection.

c. The sample recordings from English native speakers (L1) are created through converting the same experimental wordlist into a natural sounding voice by US English/Salli in ttsmp3.com platform. TTS (2013) is the online service platform to convert written text into a natural sounding voice.

d. As an essential tool for observing whether there is an epenthesis of segments, the Praat 6320 software (Paul Boersma & David Weenink,1992-2022) that can do phonetics by computer and display the waveform and spectrum of the sound file. The is used to compare, label, classify, and analyze all the recordings collected in this experiment.

e. The correct pronunciations are marked by researcher as R(right) in the process of pronunciation statistics, while all wrong pronunciations including epentheses at the beginning and middle of the syllable will be summarized as W(wrong) pronunciations since epentheses in this paper only calculated as E when they exit at pronunciation of plosive in the word coda position, for example, the insertion /u/ is marked as Eu, the insertion /i/ is marked as Ei, and the insertion /ə/ is marked as Eə.Particular attention is paid to the fact that some words are easily confounded with similar pronunciation like globe/gləʊb/ and global/gləʊb(ə)l/. Here /gləʊb(ə)l/ is marked as W (wrong), while/g ləʊb (ə)/is calculated as an epenthesis.

f. The second questionnaire (see Appendix 4) is the selection list of phonetic transcriptions of the word list, which is designed to further verify the recording

of doubtful points arising from reading aloud. The specific epentheses of each speaker are finally counted out (see Appendix 5).

4. RESULTS

4.1 The insertion of/ə /, / u /, / I /, / ou /, / t/are recognized after the final plosive in word list

The total number of pronunciations in this experiment is 648, including 452 correct pronunciations, 100 incorrect pronunciations, and 96 epentheses. Typical types of epentheses are correspondingly 57 /ə/,33 / u /, 4 / I /, 1 /t/ ,1 / ou/(see table 3).

Table 3.Typical types of epentheses

Typical types of epentheses							
All	R	W	/ə/	/u/	/i/	/t/	/oʊ/
648	45 2	100	57	33	4	1	1
			96				

4.2 / u/inserted after final b and P, while additional /ə/insertion after final d

Another striking phenomenon is caught that all 33 / u/insertion occurs after b and p, while 16 /ə/ insertion was created after d, which is twice that of
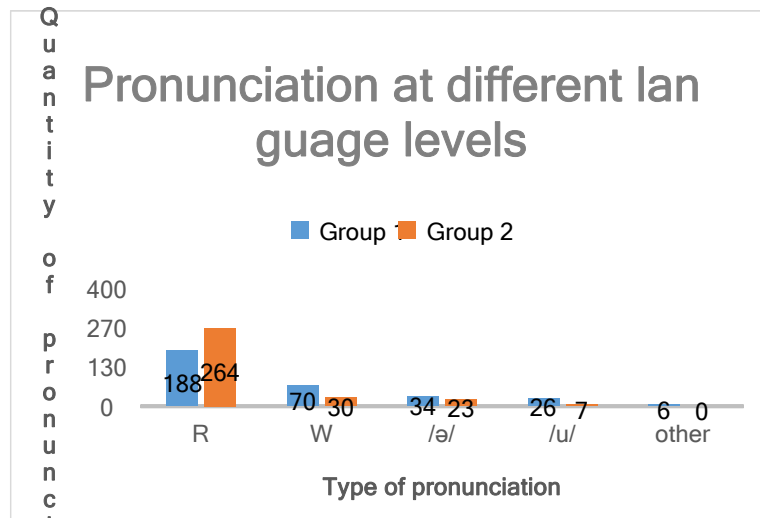
other plosives (see Table 4).

Table 4. The epentheses are divided into two groups.

Plosives / Epentheses	Group 1						Group 2					
	b	p	d	t	g	k	b	p	d	t	g	k
R	26	29	31	34	37	31	37	47	44	46	44	46
W	10	6	12	15	12	15	9	1	3	4	8	5
/ə/	7	4	9	4	5	5	4	3	7	4	2	3
/u/	11	15	0	0	0	0	4	3	0	0	0	0
/i/	0	0	2	1	0	1	0	0	0	0	0	0
/t/	0	0	0	1	0	0	0	0	0	0	0	0
/oʊ/	0	0	0	1	0	0	0	0	0	0	0	0

4.3 Epentheses decreased by 54.5% as the language level improved.

It can be seen in Fig. 3 that the first group has 188 correct pronunciations, 70 incorrect pronunciations and 66 epentheses, while the second group has 264 correct pronunciations, 30 incorrect pronunciations and 30 epentheses. The second group had higher correct pronunciations and fewer incorrect pronunciations, and had 54.5 percent fewer epentheses than the first group as their language levels improved.

Figure 3 Pronunciation at different language levels

Pronunciation at different lan guage levels

Quantity of pronunciation

■ Group 1 ■ Group 2

400
270
130
0

188 264 | 70 30 | 34 23 | 26 7 | 6 0

R | W | /ə/ | /u/ | other

Type of pronunciation

5. DISCUSSION

5.1 Do English learners in Chinese universities experience the phenomenon of epenthesis when pronouncing the plosive at the end of a syllable? What are they if there is an epenthesis?

The pronunciation grab/græb/ is used to compare and analyze epentheses in pronouncing the plosive sound of b at the end of the syllable between L1 English speaker and L2 English learners. Figure 4 is the pronunciation of grab/græb/ by L1 English speaker, recorded by praat software. Figure 5 is the pronunciation of grab/græb/ by L2 English learner A, without epentheses. Figure 6 shows L2

English learner b 's pronunciation of grab/græb/ with insertion/u /.

Figure 4. The pronunciation of grab/græb/ by L1 English speaker recorded by praat software
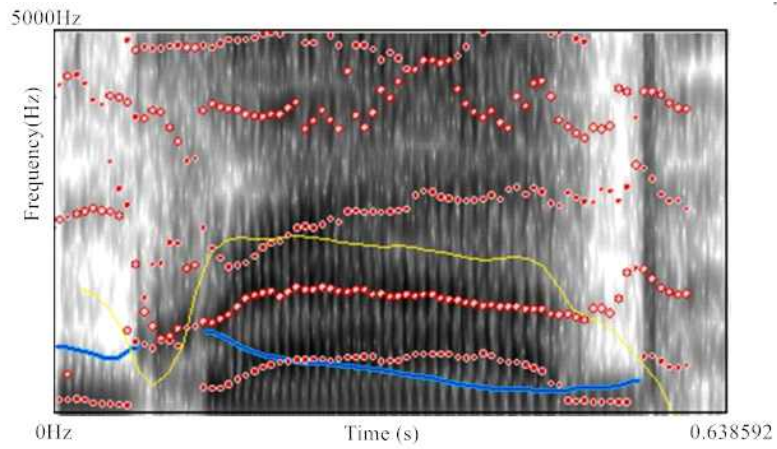

Figure 5. The pronunciation of grab/græb/ by L2 English learner A, without epentheses, recorded by praat software
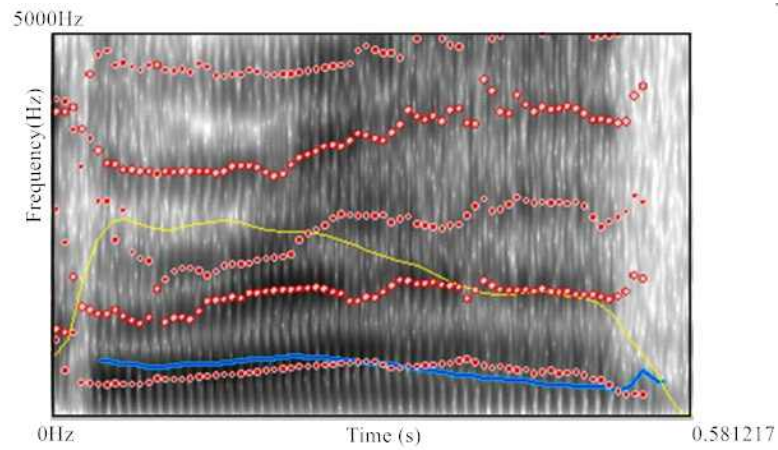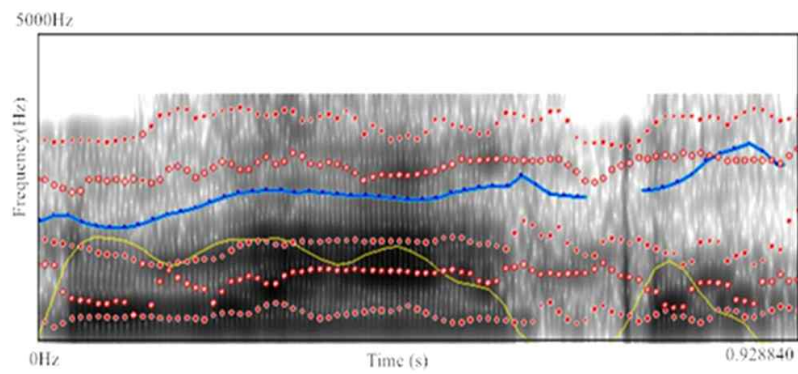
Figure 6. L2 English learner B 's pronunciation of grab/græb/ with insertion/u /, recorded by praat software

It can be seen by comparing Figure 4 and Figure 5 that there is no formant horizontal bar after/b /. This indicates that both L1 English speaker and L2 English learner A do not have an epenthesis after/b

/. In addition, when we compare Figure 6 with Figure 4 for the L1 English speaker, there is a clear form factor on the graph, which indicates that L2 English learner B inserted a sound on the /b/ pronunciation. Therefore, the following conclusion can be developed that Chinese L2 English learners will construct the epentheses when pronouncing the plosive sound at the end of a syllable. In addition, the results of experiment show 15% epentheses are created in pronouncing the plosive sound at the end of the syllable, including 57 /ə/,33 / u /, 4 / I /, 1 /t/,and 1 /ou/. This conclusion is different from statistical results developed by some researchers (Liang, 2003), (Zhou, Bi, Dai, Chen, 2011), (Chen,2012) who believed the type of insertions at the end of the syllable were only one /ə/. Fan (2008) studied epentheses/ə/at the end of the syllable in the pronunciation tests of three Chinese students from Beijing city but studied in USA, for instance, hand/hænd/was read as/hændə/and kicked/kɪkt/ was read as /kɪktə/ through OT and Language Sense theory.

5.2 What are the characteristics or rules of those epentheses?

All of the insertions/u/occurs after b and p, and 16

insertions/ə/after d were discovered in experiment, which verifies professor Du's discoveries in 1985 that Chinese students in English vowel consonant clusters commonly insert the vowel /ə/, but some will insert/u/after the pronunciation of/p/based on his years of teaching experience. Chomsky& Halle (1968) clarify that English pronunciation is determined by phonological rules and environment, and English plosives/p/and/b/in phonology must follow the rule of releasing or losing plosive feature at the final coda position. If this rule is not adequately implemented, epentheses/u/will be inserted. Another significant reason for this phenomenon is the influence of the L1 grammar. The p and b in Chinese L1 Gammar Mandarin are pronounced as坡/pō/ and 波/bō/, the pronunciations of /pō/ and /bō/ are greatly similar to/pu/and /bu/ in language sense theory, and praat software. The same situation appears in the pronunciation of d, The d in Mandarin is pronounced as 嘚/də/, which is the same with epenthesis /də/. This phenomenon can be explained by the hypothesis of equivalence classification developed by Flege (1987),which believes that phonemes can be divided into two categories in L2 grammar, one is the different phones that can not find similar counterparts in the L1 grammars, another is the similar phones that exists in the L1 grammar, and L2 learners will classify similar phones into a certain category of their mother tongue, so that their

pronunciation always has a native accent. What is more, Ohala (1993) proposes hypocorrection to explain this phenomenon by that the phonetic environment of the sound-changing segment is misjudged by the listener as the characteristics of the sound-changing segment itself, resulting in speech variation, such as the delay of the vocal cord vibration of the subsequent segment after the plosive sound (vot value is larger). The listener misjudges these as features of the plosive segment itself, and then the plosives with the epentheses /i /, /u /, /t / will be generated by the listener.

5.3 Will this phenomenon decrease as the language level of the learner increases?

Xiao&Zhou (2016) pointed out epentheses phenomenon was not related to the learner 's language level in pronunciation research of Chinese EFLs acquiring beginning of consonant clusters. This experimental data, however, reached the opposite conclusion, showing that the second group, which had a higher level of language, had more correct pronunciations and fewer incorrect pronunciations, and that the number of epentheses decreased by 54.5 percent compared to the first group. According to the interlanguage theory proposed by Selinker (1972),An interlanguage formed

by learners on the basis of the input of the target language is different from its first language (L1 grammar)and the target language (L2 grammar), but it gradually develops into the target language with the progress of learning.

6. AN OT ANALYSIS

6.1 Basis of Optimality Theory

Optimality Theory (OT), proposed by Prince&Smolensky in 1991, holds that languages around the world share the same set of grammatical constraints, and the only difference lies in the order of constraints. Language acquisition is a process of learning to rank constraints. All markedness constraints are higher than faithfulness constraints in the initial grammar of mother tongue acquisition, and then the learner progressively degrades some of the constraints until they form the correct order. The theory advocates judging whether the surface expression item conforms to the grammar, not to see whether it conforms to all the constraints in isolation, but to compare all possible candidates, among which the candidate that satisfies the most

constraints is consistent with the grammar, that is, the candidate that conforms to the grammar does not necessarily meet all the constraints. The optimality theory provides a different perspective on the understanding of phonological phenomena, which is able to discover the internal relations between some seemingly unrelated phenomena and gives maximal generalization, which suggests different analytical methods for some specific problems in phonology that have not been solved for a long time.

The core idea of Optimality Theory is that language is a mechanism to resolve contradictions, its grammatical rules are composed of a series of conflicting constraints in order of importance: C1 > C2 >... Cn (C1 > C2 indicates that constraint 1 is higher than constraint 2, that is, more significant). Each constraint makes some stipulations on the form of language output (output) such as ＊ŋ (ŋ cannot be at the beginning of the word), and this grammatical mechanism will input numerous corresponding candidate output values, and the final output form is the candidate value with the lowest degree of violation.

The basic types and features of constraints and the process of choosing the output form are

introduced shortly below. First, according to the OT syntax, there are two types of constraints: markedness constraints and faithfulness constraints..The markedness constraint requires the output form to conform to a certain phonetic structure standard such as * ComplexCoda is a markedness constraint that prohibits vowel consonant clusters. The faithfulness constraint requires some consistency between the output and input forms to obtain sufficient forms of lexical transformations to express different semantics..For example, DEP-IO requires any vowel in the output to have a corresponding value in the input, that is, no insertions are allowed..MAX-IO requires that any consonant in the input has a corresponding value in the output, that is, delectation is not allowed.

Second, the markedness constraint and the faithfulness constraint may conflict with each other. For example, in order to adequately satisfy * Complex Coda, it is inevitable for a language to insert vowels and delete consonants to remove constraints such as DEP-IO or MAX-IO in the final consonant cluster of the input. Conversely, if a language is to sufficiently satisfy DEP-IO and MAX-IO, the final consonant group in the input will appear in the output form, i.e. * Complex Coda

cannot always be followed. Third, all constraints are ranked according to their importance in a language. For example, if a language thinks that forbidding the final consonant cluster is more critical than not increasing the vowels, then * Complex Coda ranks higher than DEP-IO (* Complex Coda > DEP-IO). Fourth, all constraints can be violated, but the consequences of violating higher constraints are more severe than violating lower constraints, and the final output form is always the candidate that violates the least constraints. The following OT tableau shows the process of selecting the output form.

Table 5. OT tableau

Input form	Constraint 1	Constraint 2	Constraint 3
a. ☞candidate a	*	*	*
b. candidate b	*	**!	

Related constraints on candidates are listed from left to right in descending order of importance in Table 5 (The dotted lines will be created if there is no hierarchical difference between the two constraints).When (a) candidate violates constraint1, the corresponding cell is marked with *. The final output form is marked by the symbol ☞ of the best candidate. The highest and most influential constraint 1 in

the preferred table 5 cannot determine the output form because both candidate (a) and (b) violate it once. The evaluation continues by constraint 2, which candidate (a) violates constraint 2 once and (b) violates it twice, then (b) violates it more profoundly, thus (b) is ruled out a winner. It is worth noting that (b) is really better than (a) in constraint 3, but (b) 's violation of the higher ranking constraint 2 is already fatal (indicated by!), which makes constraint 3 invalid. The shaded portion of the table indicates that the information in the table is not crucial for the choice of output format, since the optimal output value has already been chosen.

6.2 Initial Grammar and Interlingual Grammar with Constraints Ranking

6.2.1 Initial Grammar with Constraints Ranking

The results of the comparison of English and Mandarin consonant system and syllable structure in Section 2 show that English has a large number of consonant clusters, while Mandarin does not allow consonant clusters, and the syllable tail consonants can only be nasal consonants (N) -n or-q. Constraints on the sequence of syllable structures in English and Mandarin can be obtained initially as follows.

The following English constraints are ranked:

(1) MAX-IO, DEP-IO, IDENT-IO (F) >> ＊COMPLEX Coda

Mandarin constraints are ranked below:

(2)＊COMPLEX Coda >> MAX-IO, DEP-IO, IDENT-IO (F)

MAX-IO (anti-deletion), DEP-IO (anti-insertion), IDENT-IO (F) (consistency) are faithfulness constraints, and ＊COMPLEX Coda (complex syllable coda are not allowed) is a markedness constraint. It can be seen that the constraint sequence of the English syllable structure is the faithfulness constraint dominating the markedness constraint, while the constraint sequence of the Mandarin syllable structure is the markedness constraint dominating the faithfulness constraint.

Markedness theory (chomsky& Halle, 1968) believes that unmarked components are more universal, more basic and more commonly used. Therefore, four consonant clusters are more markedness than one consonant cluster in the consonant clusters at the end of English syllables.

Which means ＊CODA/N (N is nasal consonant/n/or/ŋ /) should be ranked after other constraints, and ＊CODA/X (X is other consonants

except nasal consonant/n /) should be ranked before * CODA/N since there can be no other consonants as syllable coda except nasal consonant (N)/n/in Mandarin. The sequence of constraints on syllable structure in English and Mandarin can be updated as follows.

The following English constraints are ranked:

(1) MAX-IO, DEP-IO, IDENT-IO (F) > > * COMPLEX Coda ,*CODA/X,CODA/N

Mandarin constraints are ranked as follows:

(1) * COMPLEX Coda ,*CODA/X>> MAX-IO, DEP-IO, IDENT-IO (F)>> CODA/N

6.2.2 Interlanguage Grammer with Constraints Ranking

Seventy percent of the correct consonant pronunciations in the experiment showed that most of the students had mastered the grammar of the target language. Thus, the interlingual grammatical constraints rank are already the same as in English:

(1) MAX-IO, DEP-IO, IDENT-IO (F) > > * COMPLEX Coda ,*CODA/X,CODA/N

However, the epentheses of different phonemes after the syllable coda is a violation of the DEP-IO

(anti-insertion) constraint, so the order of the interlanguage fidelity constraint of the participants in the epentheses error should be:

(2) MAX-IO, IDENT-IO(F)>>DEP-IO

The epentheses of different phonemes after the syllable coda turns the syllable coda into the syllable beginning, which is caused by the elevated ranking of * Complex Coda:

(3)*COMPLEX Coda>>MAX-IO, IDENT-IO(F)>>DEP-IO

The results of the experiment showed that students only inserted one vowel to eliminate the consonant cluster instead of inserting two vowels, indicating that they had mastered some final consonants that were not allowed in their mother tongue, thus * Coda/X ranking was lowered. The interlanguage grammar constraint ranking in experiment based on (1),(2),(3) will be the final (4).

(4)*COMPLEX   Coda>>MAX-IO, IDENT-IO(F)>>DEP-IO>>*Coda/X,*Coda/N

An example is given below:

Table 6: /sɪlk/ →/sɪlkə/,/sɪlki/

	*COMPLEX coda/sɪlk	MAX-IO	IDENT-IO(F)	DEP-IO	*CODA/X	*CODA/N

	/					
a. /sɪlk/	*!				**	
b. /sɪk/		*!			*	
c. /sɪək/			*!		*	
d. ☞ /sɪlkə/				*	*	
e. ☞ /sɪlki/				*	*	
f. /sɪləkə/				**!		

In Table 6, candidate (a),(b),(c) violated respectively *COMPLEX coda, MAX-IO, IDENT-IO (F), candidate (d) and (e) had no violation of MAX-IO, and IDENT-IO (F), but violated DEP-IO. (f) had violated DEP-IO twice because it inserted/ə/twice. Candidate (d) and (e) were difficult to distinguish which one was the winner. Fan (2008) used perceptual maps to point out that/ə/is the shortest pronunciation of all vowels, and its pronunciation is flexible and easy to integrate with the surrounding pronunciation environment. This leads to its insertion, which can eliminate consonant clusters and make errors less easily detected. Therefore, this pronunciation is usually used in the amplification phenomenon, thus the constraint ranking (5) is DEPi>> DEPə.

Therefore, the interlanguage grammar constraint ranking in experiment based on (1),(2),(3),(4),(5) will be the final (6).

(6) *COMPLEX Coda>>MAX-IO, IDENT-IO(F)>>DEPi>>DEPə>>*Coda/X,*Coda/N

An example is given below:

Table 7: /sɪlk/ →/sɪlkə/

/sɪlk/	*COMPLEX coda	MAX-IO	IDENT-IO(F)	DEPi	DEPə	*CODA/X	*CODA/N
a. /sɪlk/	*!					**	
b. /sɪk/		*!				*	
c. /sɪək/			*!			*	
d. ☞ /sɪlkə/					*	*	
e. /sɪlki/				*!		*	
f. /sɪləkə/					**!		

Although the increase of ə is a major tendency, some students will add u after the lip sound P and d. This is a phenomenon of assimilation of pronunciation parts, that is, the + lip feature of consonants spreads to the vowels that follow. It sounds less abrupt when the vowel being inserted

shares a phonetic feature with the previous consonant. According to optimality theory, it is the following constraint that causes this + lip feature to spread. Alan&Paul (1993) mentioned constraint Agree-lab in optimality theory: constraint interaction in generative grammar that vowel inserted after constant with +lip feature. DEPu forbids the insertion of /u/, which implies that the constraints Agree-lab and DEPu conflict. The experimental results show more/u/than/ə/ insertion after p and b, which means Agree-lab is more significant than DEPu in this interlanguage grammar. Thus the constraint ranking (7) Agree-lab>>DEP u>>DEPə. The interlanguage grammar constraint ranking in experiment based on (3), and (7) will be the final (8).

(8)∗ COMPLEX Coda>> Agree-lab>>DEP u>>DEPə>>∗Coda/X,∗Coda/N

An example is given below:

Table 8: /dɪˈveləp/ →/dɪˈveləpu/

/dɪˈveləp/	∗COMPLEX coda	Agree-l ab	DEP u	DEPə	∗CODA /X	∗CODA /N
a. /dɪˈveləp/	∗!				∗∗	
b.☞ /dɪˈveləpu/			∗	∗		
c.		∗!		∗∗		

/dɪˈveləpə/						

6.2.3 Implications for the Constraint Ranking

The above analysis shows that the intermediate grammar for Chinese college students to learn English is *COMPLEX coda >>Max-IO,IDENT-IO(F)>>DEPi,DEPu>>DEPə>*code/X,*Coda/N. Comparing this intermediate grammar with the original grammar of English and Mandarin, we can see that Chinese university students have different types of errors caused by the interference of Mandarin in their English learning process.

7.CONCLUSION

This paper makes an empirical study on the epentheses in Chinese college students' pronunciation by the aid of Praat Software, discovered that 15% epentheses created at the pronunciation of polisves in the word final position, which includes/ə /, /u/,/i/, /t/,and /ou/. What's more, the most frequent epentheses is/ə/with 57, and 16 of them were located after plosive b in the word final position. A vital reason is that these phenomenons are influenced by Chinese L1 grammar, the pronunciation of b, p, d in Mandarin is 坡/pō/ and 波/bō/ 嘚/də/,which is extremely

similar to epentheses/pu /, /bu/ and /də/. Both the hypothesis of equivalence classification (Flege, 1987) and hypocorrection (Ohala, 1993) vertified similar phonemes in L1 grammar interfere with phonetic acquisition of L2. Based on the interlanguage theory (Selinker, 1972) and Optimality Theory (Prince & Smolensky, 1991), this paper explains and summarizes the interlanguage grammar of Chinese college students in the process of transferring from the initial grammar of Mandarin to the target grammar of English as follows: *COMPLEX coda >>Max-IO,IDENT-IO(F)>>DEPi,DEPu>> DEPə>*code/X,*Coda/N. It can be seen that Chinese university students have different types of errors due to the interference of Mandarin in their English learning process. Another fascinating finding in the second questionnaire is that some students complete the correct pronunciation but make the wrong phonetic alphabet choice, while some students choose the correct phonetic alphabet but complete the wrong pronunciation, which needs to be validated by additional experiments. However, the author of this experiment acknowledges that the design of the word list is not sufficiently diverse and the results of this experiment lack support, which is expected to be improved in future studies.

REFERENCE

TENCH.P.(2003). *Non-native speakers´misperceptions of english vowels and consonants: Evidence from Korean adults in UK*［J］. IRAL2003(41) : 145–173.

Shinsook Lee·MiHui Cho.(2005). *Perceptiong and poduction of consonant clusters by Korean leaners of English*［J］. English Language and Literature□2005 (50) : 1101–1132 .

Mauda, H. Arai, T. (2008).*Perception of consonant clusters in Japanese native speakers: influence of foreign Language learning* ［C］// The Proceedings of the 2nd ISCA Workshop on Experimental Linguistics, Exling, 2008.25-27

Archibald, J .A. (1997).*The acquisition of English stress by speakers of nonaccentual languages: Lexical storage versus computation of stress. Linguistics* 35:167-181.

Archibald, J. (1998). *Second Language Phonology.* Philadelphia: John Benjamin's.

Broselow, E. (1988).Prosodic phonology and the acquisition of second language phonology. In Flynn, S.and W. O'neil (eds), *Linguistic Theory in Second Language Acquisition.* The Netherlands: Kluwer Aca-demic Publishers.

Broselow, Ellen . Hyer Baeark. (1995).Moreconservarionn

second language prosady. Injohn Archibld (ed), *Phnonological Acouision and Phonologeical.Thery,*Hillsdale,NJ:LawrenceEHlbaum,15 1- 168.

Flege, J. E. (1987).*The Production of "new" and "similar" phones in a foreign language : Evidence for the effect of equivalence classification* [J] . Journal of Phonetics 15 : 47-65 .

Fan, Ye. (2008).*Epenthesis in L2 Complex Codas. An Optimality Iheory and Pmap Account.* Journal of Foreign Languages. January Vol31 No1.2008.

Gui, Cankun. (1985) *Applied Phonetics of American English* [M]. Shanghai : Shanghai Foreign Language Education Press, 1985.

Chomsky, N. and Halle, M. (1968). *The Sound Pattern of English.* Harper Row, New York.

Ohala, J J. (1993)*The Phonetics of Sound Change. Jones C.(ed.)Historical Linguistics:*

Problems and Perspectives. London: Longman: 237-278 .

Selinker, L. (1972).*Interlanguage Product Information International Review of Applied Linguistics in Language Teaching*, 10, 209-241.

Prince , A&Smolensky, P. (1993).*Optimality Theory－ Constraint Interaction in Generative Grammar.* 1993.

Prince Alan and Smolensky Paul. (1993) *Optimality Paul Theory: Constraint in te raction generative in Report no*

grammar[R]. Report no RuCCS-TR-2 New Brunsw NJ Rutgers University Center NJ: Rutgers University Center for Cognitive Science 1993.

Zhou, Hengyan. (2014).*The phenomenon of epenthesis in English pronunciation*. Journal of Kaifeng Institute of Education. Vol. 34.No.6 Jun.20.2014.

Li, Qiaolan.(2013).*The Phenomenon and Distribution of Erhua in Hebei Dialect*. Journal of Baoding University. Vol 26.No.4.July 2013.

Yanzhi, Cui (2019).*A study on Production and Perception of English Coda Nasals by Contonese and Mandarin Speakers*.2019.

Tong, Shuwei.(2011).*A Study on the Pronunciation Features of Chinese College Students ' English Syllable End Consonant Clusters under the Framework of Optimality Theory*.2011.

Wang, Ping(2009). *A corpus-based Survey of Epetheses by Chinese College Learners of English*.2009.

Feng, You.(2005). *A corpus-based Survey of Epetheses by Chinese College Learners of English*.Foreign Language Teaching and Research. Vol 37.No.6.November 2005.

Meng, Cangpei. (2012).*An Optimality theory Analysis of Chinese Miao nationality Students ' English Pronunciation in Epenthesis and Deletion*. Journal of Guizhou Normal College. Vol.28.No.7. July.2012

Alan, Cruttenden. (2001). *Gimson's Pronunciation of*

English, 6th edition. London: Edward Arnold. 2001. Pp. xx + 339. ISBN 0 340 75972 0. December 2002.

Lin, Tao & Wang, Lijia, (1992). *Course of Phonetics*. Beijing: Beijing University Press

Zheng Haitang, Chen Yongjie. (2017).*New Horizon English Course-Listerning and Speaking Version 1.*Foreign Language Teaching and Research Press.2017.

Shanghai Zhongyan Network Technology Co., Ltd,(2008). wenjuan.com.Available at https://www.wenjuan.com/?from=404.

Aconvert. (2000). aconvert.com. Available at https://www.aconvert.com/cn/audio/m4a-to-mp3/

TTS (2013).available at https://ttsmp3.com/

Paul Boersma & David Weenink (1992-2022):Praat: doing phonetics by computer [Computer program].Version 6320, retrieved 23 January 2022 from https://www.praat.org.

Liang Qinghe. (2003). *A comparative study of the pronunciation characteristics of English blasting consonants ／ t ／, ／ d ／.* Journal of Social Science of Jiamusi University. Vol. 21 No.6. Dec.,2003.

Zhou Weijing, Bi Yifei, Dai Lei, Chen Hong.(2011). *An Exploratory Experimental Study on College Students＇Acquisition of English Burst.* Journal of Jiangsu University of Science and Technology(Social Science Edition).Vol.11.No.2.Jun.2011.

Chen Yongbing (2012). *Analysis of the phenomenon of phonetic amplification in interlanguage phonetic systems.* Journal of phonetic ontology research. 2012.

<Abstract>

COLLEGE STUDENTS' ENGLISH PRONUNCIATION OF PLOSIVES IN THE WORD FINAL POSITION

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The purpose of this paper is to study the epentheses phenomenon of the final position of the plosives in English pronunciation by Chinese L2 English learners. This study experimentally collected the pronunciation of two groups of Chinese college students at different levels of English and found that they would commonly insert the vowel /ə/ after pronunciation of d, and insert /u/ after the pronunciation of b and p at the end of a syllable, and the group with a higher level of language had more correct pronunciation and fewer epentheses.It can be summarized through OT analysis of the experimental results that the interlanguage grammar of

Chinese college students in the process of transferring from the initial grammar of Mandarin to the target grammar of English is as follows: *COMPLEX coda >>Max-IO,IDENT-IO(F)>>DEPi,DEPu>> DEPə>*code/X,*Coda/N. A better understanding of this and training will help Chinese L2 English learners to obtain the correct pronunciation of the final position of the word plosives.

Key words

Chinese L2 English Learners; English pronunciation; plosives; epenthesis; Optimality Theory