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Age-related Factors and the Specifics of Second Language Phonology*

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This study tests whether age-related factors serve as effective predictors in one specific area of adult second language (L2), i.e. English word stress assignment by native speakers of Chinese. A perceptual stress preference task with English non-words of 2 to 3 syllables was carried out. Comparing the performance of English natives and Chinese EFL learners, it is found that age factors are good predictors of not only perceived global foreign accent but also the domain of L2 word stress placement. In addition, while both age of arrival (AOA) and length of residence (LOR) predict native-like stress placement of L2 learners, the model suggests that the predictive ability of AOA is stronger than LOR. It is therefore suggested that non-native-like stress placement is a substantial contributing factor to perceived foreign accent.

Key words: second language phonology, English word stress placement, Chinese-English interlanguage

1. Introduction

A great deal of debate has been generated over the years on the issue of whether complete attainment is possible in adult second language (L2) acquisition (see a review by Piske, Mackay, and Flege 2001). In predicting the perceived foreignness of L2 pronunciation, the two variables which have been most fully investigated are age of arrival (AOA) and length of residence (LOR). While the effect of AOA is widely acknowledged in the literature, previous research has produced somewhat mixed results on the effect of LOR, with studies disagreeing on whether a correlation can be found between LOR and the perceived foreignness of the L2 accent (e.g. Tahta, Wood, and Loewenthal 1981 and Riney and Flege 1998). More importantly, it should be pointed out that much of the research on the age effect looks at "global accent" rather than any specific part of the L2 phonological system. This study therefore aims to examine the effect of these two non-linguistic factors, AOA and LOR, in the specific case of the acquisition of word stress. The issue is significant for at least two reasons. From a theoretical perspective, investigating the age effect in L2 stress development can tell us how AOA and LOR might affect this particular aspect of L2 phonological acquisition and explain how this domain contributes to the global accent of L2 learners. Also, from a practical perspective, the findings will provide several

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implications for English learning and teaching.

This paper is organized as follows. Section 2 provides a review of the main findings of how L2 phonological acquisition is affected by age-related factors and outlines several issues which require further investigation. Section 3 presents an experiment which investigates whether age variables affect the assignment of L2 English word stress and offers a general discussion of the results. Section 4 concludes the paper.

2. Age factors

In this section we provide a brief review of the two important age-related factors, age of arrival (AOA) and length of residence (LOR), addressing the issue of whether the ability of L2 learners to acquire native-like phonology declines gradually or catastrophically, as well as the putative age by which a person must be exposed to an L2 if native-like phonology is to be guaranteed, and whether or not LOR is an effective predictor of L2 foreign accent.

2.1 Age of arrival

In L2 speech, perceived foreign accent is often used as an index for the degree of success with which a new language has been acquired. Foreign accent refers to the degree of L2 learners' non-target pronunciation as perceived by native speakers of the target language. In most previous studies of this question (e.g. Asher and Gracia 1969, Fathman 1975, Flege and Fletcher 1992, Oyama 1976, Patkowski 1990, Tahta, Wood, and Loewenthal 1981, and Thompson 1991), subjects were recorded as they read written materials aloud, described some personal experience, or repeated speech materials. Native speakers of the target language were then asked to evaluate the recorded L2 speech samples using a rating scale to indicate the degree of a foreign accent they perceived. Subjects' AOA (i.e. age of first exposure to a predominantly L2-speaking country) was found to strongly correlate with perceived L2 foreign accent, such that the earlier in life one learns an L2, the better pronunciation one is likely to have.

A relevant question to ask here is whether age-related ability in learning a new language declines gradually or sharply. Both views are found in the literature. It is often suggested that there is a critical period for human speech learning, during which there is a loss of neural plasticity, and if L2 learning begins after this critical period is past, successful acquisition is usually regarded as impossible (e.g. Lenneberg 1967, Patkowski 1980, 1990, and Scovel 1969, 1988). According to the critical period

hypothesis, a clear difference should be seen between foreign accent ratings obtained for individuals who began learning the L2 during the critical period and those who began learning once the critical period was past. However, a number of studies have shown that the effect of AOA on L2 learners' target-like pronunciation declines gradually. The gradual increase in degree of L2 foreign accent with increasing AOA made both Oyama (1976) and Long (1990) suggest that the term "sensitive" is more accurate than "critical" for L2 learning. In addition, different suggestions have been made as to when the critical or sensitive period for L2 speech learning ends; Scovel (1988) suggested the age of 12 years while Patkowski (1990) suggested 15 years. Long (1990) indicates that an L2 is usually spoken without a foreign accent if it is learned by the age of 6 years, but a foreign accent would be detected in most learners who begin learning after the age of 12 years. In contrast to the view that some sort of biologically-determined critical period does exist (whether it shuts down suddenly or gradually), some researchers have sought other explanations, bearing in mind particularly the observation that an AOA of less than 6 years does not always guarantee accent-free L2 speech. Flege, Frieda and Nozawa (1997), for example, identify the amount of L1 use as another factor which has a bearing on L2 speech accent even for learners whose AOA is less than 6 years. In their experiment, two groups of early Italian-English bilinguals were matched for AOA (6 years on average) but differed in the extent to which they used the L1. The groups were found to have different degrees of foreign accent, and specifically, the group of subjects who had used the L1 (Italian) intensively had more of a foreign accent.

2.2 Length of residence

In addition to AOA, another important non-linguistic variable has been "length of residence" (LOR), that is, the number of years that L2 learners have spent in the community in which the L2 is the predominant language. While the effect of AOA is widely acknowledged in the literature, previous research has produced somewhat mixed results on the effect of LOR, with studies disagreeing on whether a correlation can be found between LOR and the perceived foreignness of the L2 accent. Studies that have reported an influence of LOR on L2 foreign accent include Asher and Garcia (1969), Purcell and Suter (1980), Flege and Fletcher (1992), Flege, Munro, and MacKay (1995) and Flege, Yeni-Komshian, and Liu (1999). However, several studies that have not found an effect of LOR include Oyama (1976), Tahta, Wood and Loewenthal (1981), Flege (1988), Piper and Cansin (1988), Thompson (1991), Elliott (1995), and Moyer (1999). It has recently been argued that the discrepant findings on LOR effects can be unified under one interpretation: it is possible that both LOR and

AOA are predictors at the early stages of L2 acquisition, but the effects of LOR taper off in later stages (Piske, MacKay, and Flege 2001). This is because no matter how young L2 learners are when they arrive in the community of the target language, if they have not been exposed to the L2 long enough, their proficiency cannot be particularly high.

It is important to point out at this stage that much of the research on the age effect looks at "global accent" rather than any specific part of the L2 phonological system. However, investigating age effects in well-defined areas of the phonological system has the potential to tell us how AOA and LOR might affect different aspects of L2 acquisition. In the next section, we will have an opportunity to see if AOA and LOR act as predictors in the specific area of the acquisition of L2 English stress by native speakers of Chinese.

3. This study

The specific area of phonology which this study investigates is the assignment of primary stress in English words. For this study, monomorphemic words are used in order to define the specific area of L2 phonology which might or might not be affected by the two age-related factors discussed above. Most English morphologically simple words are two to four syllables long. Since words more than three syllables usually involve secondary stress, this study narrows down its scope to disyllabic and trisyllabic words. Two well-studied patterns of English word stress are tested. The first one is the stress contrast between nouns and verbs in disyllabic words with a CVCC final syllable. When the disyllabic word is a noun, stress usually falls on the initial syllable, but when it is a verb, stress usually falls on the final syllable, as shown in (1).

(1) Stress patterns in English disyllabic nouns and verbs
Initial stress: ínsect, fórest, sécond (n.)
Final stress: molést, detéct, accépt (v.)

In the metrical stress theory of English, the generalization for (1) is mainly analyzed as the difference between Noun Extrametricality and Consonant Extrametricality and the effect of the Weight-to-Stress Principle (WSP): in nouns, the final syllable is extrametrical, so stress falls on the initial syllable of a disyllabic word (e.g. *ín*<*sect*>); in verbs, only the final consonant is extrametrical (e.g. *mo.les*<*t*>), and stress falls on the final CVC syllable due to the effect of WSP (*mo.lés*<*t*>).

The second pattern of English stress which is tested here is the stress difference in

trisyllabic nouns, i.e. where antepenultimate stress is assigned when the penult is CV and penultimate stress is assigned when the penult is CVC. This is exemplified in (2).

(2) Stress patterns in English trisyllabic nouns
Antepenultimate stress: Cá.na.da, cí.ne.ma (CV penult)
Penultimate stress: a.gén.da, sur.rén.der (CVC penult)

In the metrical stress theory of English, this phenomenon is analyzed as the product of both Noun Extrametricality and the WSP as well. Put simply, the final syllable of trisyllabic nouns undergoes Noun Extrametricality first (e.g. *Cana<da>* and *agen<da>*). Then, if the penult is heavy (due to having a coda consonant (CVC)), stress falls on the penult due to the WSP (e.g. *a.gén.da*). If the penult is light (CV), then stress falls on the antepenultimate syllable (e.g. *Cá.na.da*). The above generalization and analysis are mainly based on Chomsky and Halle (1968) and Hayes (1981, 1982, 1995).

In addition to these two regular stress patterns outlined above, English stress is also characterized by a large number of exceptional cases. The term "exceptional" used here is from the metrical (rule-based) point of view. According to the distribution of English stress patterns, stress sometimes falls on the penult in trisyllabic nouns, even when the penult is light (e.g. *el<u>é</u>ven*), while in other words the penultimate syllable is closed by a coda consonant but stress still falls on the antepenultimate syllable (e.g. *cál<u>en</u>dar*, *ché<u>mis</u>try*). These patterns are also mentioned in most of the literature on English phonology and metrical stress theory (e.g. Giegerich 1992 and Hammond 1999). However, despite the fact that English contains plenty of exceptional stress patterns, this study has adopted the generative approach which regards English word stress as rule-governed, i.e. a large class of words are assigned stress in a systematic way.

Note that, because stress phenomena are defined as "perceptual prominence" by phonologists (e.g. Chomsky and Halle 1968), this study uses a perceptual experiment to test learners' knowledge rather than a production task. This method does not obstruct our interest in how age factors affect L2 English word stress acquisition since learners' perceptual judgment (i.e. output) must be based on the knowledge they have acquired about the L2.

3.1 Experiment

We conducted a preference task based on the English stress patterns outlined above, namely, the stress difference conditioned by the syllable structure of the

penultimate syllable in trisyllabic nouns.

3.1.1 Materials

In order to avoid any effect of lexical memorization, we followed the approach of other researchers in using non-words (Guion, Clark, Harada, and Wayland 2003, Guion, Harada, and Clark 2004, Kawagoe 2003, and Pater 1997). In order to control factors such as "exceptional" cases and phonological similarities, the non-words were carefully designed. First, two hundred pseudo-words of two and three syllables were constructed. They all followed English phonotactic rules and syllable construction restrictions, based on Hammond (1999). Five native speakers of English were then interviewed and asked to read these non-words aloud based on their intuitions of how they should sound as potential English words. The stress patterns which they used were noted down. Based on how the native speakers realized these non-words, a subset of eighty non-words was chosen. All eighty had stress patterns which were agreed upon by at least four of the five native speakers (i.e. 80% agreement), and which matched the English stress generalizations stated above. Any items which violated the general English stress patterns were ruled out even if they were highly agreed upon by the native English speaking subjects—for instance, the word *chálinder* was ruled out because the stress did not fall on the heavy penultimate syllable, violating the general tendency of the mapping between CVC and stress in English. In addition, some native subjects pointed out that this word was reminiscent of real words such as *cálendar*, and the stress pattern of *calendar* is not canonical in English (compare words like *agénda* and *enígma*).

After this initial selection process, the eighty non-words were put into carrier sentence frames in locations which made them appear either as nouns or verbs. Three native speakers of English were asked to read these sentences aloud. Finally, 32 words which were assigned the same stress patterns by these three native English speakers were chosen as the experimental materials. This design procedure ensured that the test words used in the tasks were all phonotactically legitimate, and that their stress patterns were by and large regular.

The resulting 32 non-words in carrier sentences were pre-recorded in a sound recording studio by a female phonetician, a native English speaker from North America. The reason we chose a speaker with a North American accent is mainly because that is the variety which learners of English in Taiwan are primarily exposed to. She practiced reading the lists of sentences out loud at a comfortable rate and spacing the sentences equally. With the objective of obtaining naturally and consistently produced sentences, a block elicitation method was used which allowed

the speaker to maintain the same rhythmic pattern and segmental quality across comparable items. Firstly, the sentences were recorded in the block with initial stress and then in the block with final stress. After a break, the sentences were recorded in a pair-by-pair fashion. Additional repetitions were allowed when she felt dissatisfied with her previous recording. The productions were recorded on DAT tape. The sentences from the last repetition of the second block were used for the stimuli. The recordings were digitized at 22.05 kHz (16 bit) on a personal computer.

3.1.1.1 Non-words targeting the noun-verb stress contrast

Sixteen of the non-words were disyllabic and had a CVCC final syllable. Eight of them were presented as nouns and the other eight were as verbs. The final syllable was always CVCC so that any effect caused by the two extrametricality rules (i.e. Noun Extrametricality and Consonant Extrametricality) could be observed. Specifically, the initial syllable would receive stress in nouns i.e. σ .<CVCC> while the final syllable would receive stress in verbs i.e. σ.CV C<C>. In order to indicate the part of speech of these non-words, two carrier sentence frames were designed: for nouns the frame was, "The ___ is [a monosyllabic colour term]," and for verbs the frame was, "She/He is easy to ___." Each non-word had two stress patterns: initial stress and final stress e.g. *dré.sect* vs. *dre.séct*. All the test items are listed in the Appendix.

3.1.1.2 Non-words targeting the stress contrast in trisyllabic nouns

Sixteen of the non-words were trisyllabic. Two kinds of target syllables were designed: eight of the trisyllabic non-words had a light penult (CV), e.g. *na**.ti**.pa*, and eight had a heavy penult (CVC), e.g. *ba**.sil**.ka.* The target syllables all contained the front high lax vowel /ɪ/. This vowel was chosen because it could be reliably elicited due to the high grapheme-phoneme correspondence between -i- and /ɪ/, and also because it can occur both in stressed and unstressed syllables, thus allowing for the manipulation of stress without categorical changes of vowel quality. The coda consonants were chosen from four categories: nasals, liquids, fricatives and stops. Each of these had two tokens. The final syllable was either CV, CVV or CVC, and in all cases it was produced with a reduced vowel. The antepenultimate syllable was also CV, CVV or CVC, and in the case of antepenultimate stress, it is produced with a full vowel whereas in the case of penultimate stress, it is produced with a reduced vowel.

Each non-word was given two stress patterns, antepenultimate stress (e.g. *ná.tim.pa* /nætɪmpə/) and penultimate stress (e.g. *na.tím.pa* /nətímpə/). Each pair of

words was then embedded in the carrier sentence frame which indicated that it was a noun (e.g. *The ___ is blue*). All of the test items are shown in the Appendix.

3.1.2 Subjects

The L2 subjects comprised 20 native speakers of Taiwanese Mandarin who were acquiring English. They were all postgraduate students at the University of Edinburgh. They are referred to simply as the Chinese subjects from now on.

Table 1 presents detailed information for each subject: age, age of arrival in the UK/US (AOA), age when formal English instruction began in the native country (Learning Age), length of residence in the UK/US (LOR), and language proficiency test scores. The average age is 26.7 years (SD=4.4). Note that there are two countries (UK/US) listed in AOA: this is because some subjects had lived in the US before they came to the UK to study. In this case, their AOA shows the age they arrived in the US rather than the UK. Three subjects had never received any formal English instruction in their native country, and so their arrival ages were are taken as their values for the learning age variable. Two subjects had never taken a proficiency test.

Table 1. Characteristics of the Chinese speaking subjects

Subject	Age	Learning age	AOA	LOR (years)	Language Test score
5	34	13	33	1	6.0 (IELTS)
6	33	13	30	3	7.0 (IELTS)
9	20	12	12	8	643 (TOEFL)
12	21	9	9	10	--
13	25	15	18	7	8.0 (IELTS)
14	23	10	10	13	--
15	26	11	25	1	7.5 (IELTS)
16	25	11	24	1	6.0 (IELTS)
17	28	13	27	1	6.0 (IELTS)
18	26	13	25	1	6.0 (IELTS)
19	34	14	33	1	6.5 (IELTS)
21	24	11	23	1	5.5 (IELTS)
22	25	8	24	1	8.0 (IELTS)
23	24	14	22	2	587 (TOEFL)
24	30	14	27	3	7.5 (IELTS)
25	27	13	25	2	7.5 (IELTS)
26	33	13	14	19	8.0 (IELTS)
27	24	13	23	1	8.0 (IELTS)
28	24	12	23	1	5.5 (IELTS)
71	29	13	26	3	7.5 (IELTS)

Note: AOA=Age of arrival in the UK/US. LOR= length of residence in the UK/US. Length of residence is rounded to the nearest year.

The proficiency tests were either IELTS or paper-based TOEFL. In order to make the scores comparable, the approximate equivalences of the scores of the two tests (published by University of Sheffield English Language Teaching Centre) are shown in Table 2 for reference.

Table 2. Approximate equivalences of IELTS and TOEFL scores

TOEFL (paper-based)	625-680	600	575	550	525
IELTS	7.5-9.0	7.0	6.5	6.0	5.5

Twenty English native speakers also participated in the experiment for comparison. All of the English subjects were also either postgraduate or undergraduate students at the University of Edinburgh. None reported having been diagnosed with any language or reading disorders.

Each subject in both groups was paid £2 for participating in the experiment.

3.1.3 Procedure

The items were presented randomly, controlled by E-Prime software (Psychology Software Tools, 2001). In each trial, subjects were given a visual presentation of the sentence, e.g. *He is easy to dresect*, where the non-word was underlined. The sentence was displayed for 2000 msec, then two sound stimuli were presented one after the other in random order, with a 500 msec pause between the two stimuli (e.g. [hi ɪz izi tə drəsɛ́kt] and [hi ɪz izi tə drésɛkt]).

Participants were tested individually in a sound-insulated booth, which contained a desktop computer and high quality headphones. Two keys on the keyboard were labeled “1” and “2”, where “1” indicated the first sound stimulus and “2” the second sound stimulus. In each trial, the task was to determine which pronunciation of the non-word in the sentence they heard was more likely to be a potential English word, and then to indicate their decision by pressing the appropriate button. There was an interval of 1000 msec between each trial, which was calculated from the point when a button was pressed from the previous trial. When in doubt the subject was asked to guess. No replay was permitted. A practice session with 5 pairs of sound stimuli was prepared to allow the subjects the opportunity to adjust the volume of the presentation to a comfortable level and to allow them time to familiarize themselves with the task.

3.2 Results

3.2.1 Stress preferences for disyllabic nouns and verbs

The prediction was that if Chinese learners of English were sensitive to the noun-verb stress contrast, they would prefer initial stress for nouns (e.g. *dré.sect* rather than *dre.séct*) but prefer final stress for verbs (e.g. *va.réct* rather than *vá.rect*). Table 3 and Figure 1 show which kind of stress the English and Chinese speaking subjects preferred for nouns and verbs.

Table 3. Preferences for final stress according to nouns and verbs

	Nouns	Verbs
	Mean (s.d.) in %	**Mean (s.d.) in %**
Native speakers of English (N=20)	46.2 (16.3)	81.9 (13.7)
Chinese learners of English (N=20)	24.4 (19.2)	64.4 (23.4)

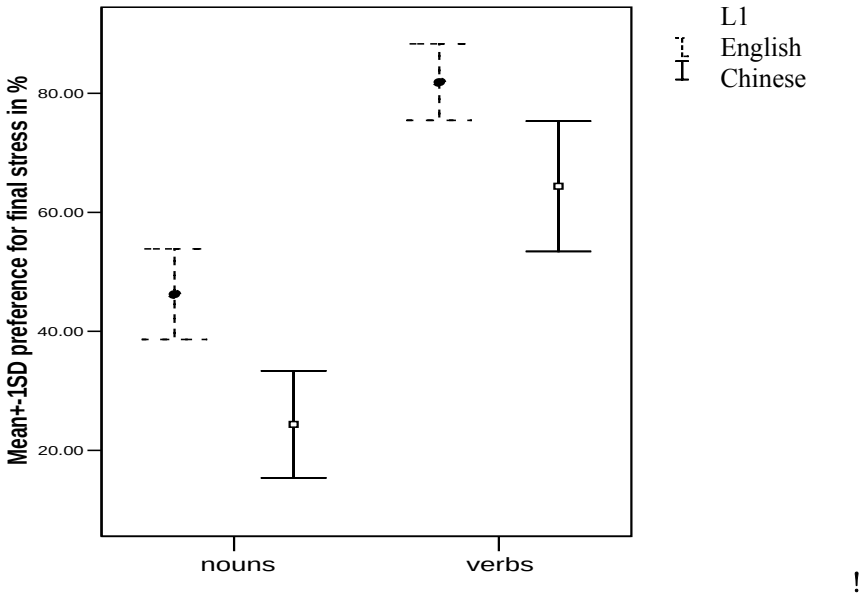

Figure 1. Responses to final stress in CV.CVCC noun and verb non-words

There was a significant main effect for the two factors MORPHO-SYNTACTIC CATEGORY [$F(1,38)=81.94$; $p<0.01$] and FIRST LANGUAGE [$F(1,38)=23.05$; $p<0.01$]. There is no interaction between MORPHO-SYNTACTIC CATEGORY and FIRST LANGUAGE [$F(1,38)=0.27$; n.s.]. The results show that both groups preferred penultimate stress for nouns and final stress for verbs, and that Chinese speaking subjects have a similar stress pattern preference to the English subjects. This suggests that Chinese learners of English are sensitive to the effect of morpho-syntactic

categories on stress assignment.

3.2.2 Stress preferences for trisyllabic nouns

The second component of the preference task tested whether or not the Chinese learners of English were sensitive to the stress attraction in the heavy penultimate syllable (CVC) of trisyllabic nouns. The prediction was that if Chinese learners of English were sensitive to the stress contrast associated with the syllable structure of penultimate syllables, they would prefer antepenultimate stress when the penult was CV (e.g. *ná.ti.pa* rather than *na.tí.pa*), but when the penult was CVC they would prefer penultimate stress (e.g. *ba.síl.ka* rather than *bá.sil.ka*).

The results presented in Table 4 and Figure 2 show the preference for penultimate stress in the two different syllable structures (CV and CVC) shown by the two groups (Chinese and English).

Table 4. Preferences for penultimate stress according to type of penultimate syllable (CV and CVC)

	CV	CVC
	Mean (s.d.) in %	**Mean (s.d.) in %**
Native speakers of English (N=20)	40.6 (14.6)	85.6 (13.7)
Chinese learners of English (N=20)	43.1 (12.5)	50.6 (26.7)

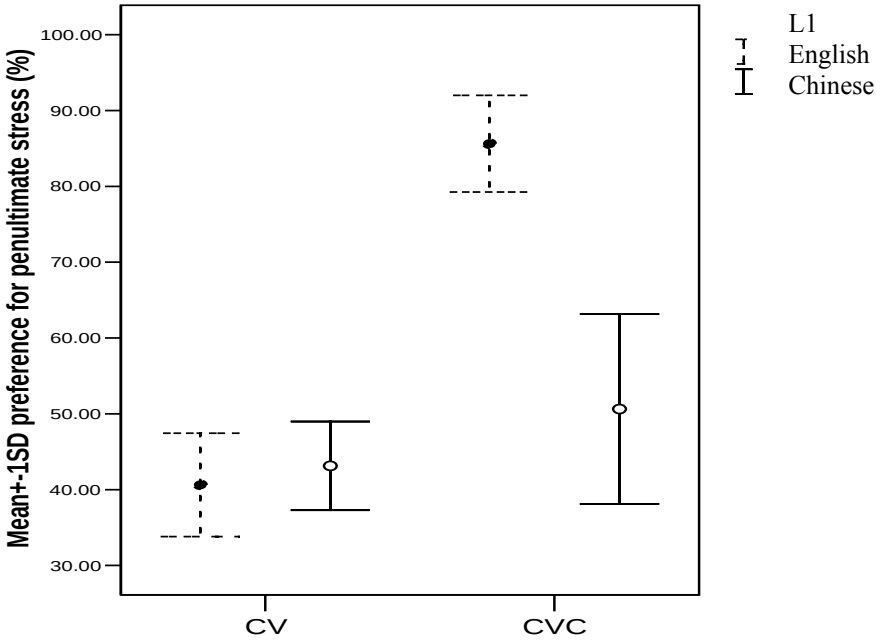

Figure 2. Responses to penultimate stress according to type of penult (CV and CVC)

There were significant main effects for both factors, SYLLABLE TYPE [F(1,38)=55.13; *p*=0.000] and FIRST LANGUAGE [F(1,38)=13.75; *p*=0.001]. In addition, there was a significant interaction between SYLLABLE TYPE and FIRST LANGUAGE [F(1,38)=28.13; *p*=0.000]. The English subjects preferred ante-penultimate stress when the penult was CV but penultimate stress when the penult was CVC, whereas the Chinese subjects showed no significant difference of stress preference between CV and CVC.

3.2.3 By-subject analysis

This section offers a by-subject analysis of the results from the preference task. Since the same subjects participated in the stress assignment of both disyllabic and trisyllabic non-words, and since there was a large amount of variation in the stress preferences for trisyllabic nouns, a further question to explore is whether any different developmental patterns appear between the L2 learners when a by-subject analysis is undertaken for the preference task.

For the distinction between initial stress and final stress in disyllabic nouns and verbs, both groups made a significantly greater choice of final stress for verbs rather than nouns. These results presented in the previous section were based on the group analyses, but it may not be the case that this contrast is found in all the L2 learners in our study. Here we define the stress contrast as the difference of stress preferences for disyllabic verbs and disyllabic nouns, i.e. the ratio of final stress in verbs minus the ratio of final stress in nouns. This enables a comparison to be made for each subject in the two groups, as shown in Table 5.

Table 5. By-subject analysis of the noun-verb stress contrast

% final stress for verbs - % final stress for nouns	English Group (Subject No.)	Chinese Group (Subject No.)
-25%	0	1 (21)
0%	1 (59)	3 (13, 17, 28)
12.5%	4 (57,58,61)	2 (5, 25)
25%	2 (42,48)	2 (12, 23)
37.5%	6 (43,45,48,49,62)	1 (19)
50%	5 (41,46,52,54,63)	4 (9, 14, 22, 26)
62%	1 (53)	2 (15,16)
75%	1 (51)	4 (6,18,24,71)
87.5%	0	1 (27)
	Mean = 36.63% (s.d. = 19.14%)	

For the trisyllabic nouns, we have seen from Table 4 and Figure 2 that the group

analysis seems to suggest that unlike the native speakers of English, the Chinese subjects were insensitive to the stress difference conditioned by CV and CVC penults. There was, however, a large amount of variability in the CVC results across the Chinese subjects (SD=26.74%). A more detailed look into the data reveals that eight of the Chinese speakers had a preference score for stressed CVC penults which was within ±2SD of the native speakers' mean. T-tests confirmed that there was no significant difference in the preference for penultimate stress in words with a CVC penult between these 8 Chinese subjects and the 20 English subjects ($t(26)=1.25$, n.s., two-tailed), while there was a significant difference in the preference for penultimate stress in words with a CVC penult between the 8 successful Chinese subjects and the other 12 less successful Chinese subjects ($t(18)=7.19$, $p=0.000$, two-tailed). In the terms of the metrical analysis, then, these 8 Chinese speakers can be regarded as showing a native-like sensitivity to the weight distinction illustrated in (3), i.e. the heaviness of the CVC penult.

(3)

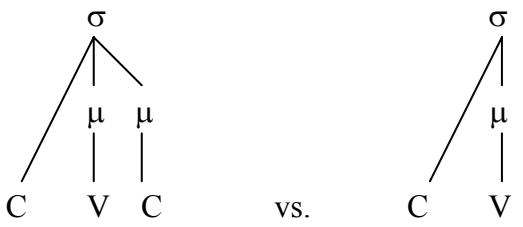

Table 6 shows the combined results of the Chinese subjects' stress preferences in disyllabic non-words and trisyllabic non-words, where the tick "✓" indicates that they are sensitive to the given contrast and the cross "✕" means they are not sensitive to that contrast.

The first pattern which can be seen in Table 6 is that the 8 L2 subjects who were sensitive to the stress attraction in trisyllabic words were also sensitive to the noun-verb stress contrast. The second pattern is that eleven L2 subjects show native-like sensitivity to the noun-verb stress contrast without showing native-like sensitivity to stress difference in trisyllabic nouns. The third pattern is lack of native-like sensitivity to both English stress patterns; this is the case with one subject. There is also a fourth developmental pattern which is logically possible, namely, one where L2 learners show native-like sensitivity to stress difference in trisyllabic nouns but not to the noun-verb stress contrast; however none of the subjects show this pattern. These results indicate that the actual pattern of development is more restricted than would logically be predicted. The presence of the second developmental pattern and the absence of its mirror pattern (the fourth possible pattern) shows that knowledge of the noun-verb stress contrast has been acquired no later than knowledge

of the rightward stress attraction in trisyllabic nouns. This suggests that the stress-related cue of morpho-syntactic categories is easily attainable for L2 speakers while the stress knowledge related to syllable structure is less easy to develop.

Table 6. Behaviour of the Chinese subjects in the two stress types

Chinese subject	Noun-Verb stress contrast in disyllabic words	Penultimate stress in trisyllabic nouns with CVC penults
12	✓ (25%)	✓ (87.5%)
22	✓ (50%)	✓ (75%)
14	✓ (50%)	✓ (75%)
27	✓ (87.5%)	✓ (100%)
9	✓ (50%)	✓ (62.5%)
13	✓ (0%)	✓ (62.5%)
25	✓ (12.5 %)	✓ (62.5%)
26	✓ (50%)	✓ (100%)
15	✓ (62.5%)	× (25%_)
16	✓ (62.5%)	× (37.5%)
18	✓ (75%)	× (25%)
24	✓ (75%)	× (12.5%)
6	✓ (75%)	× (37.5%)
71	✓ (75%)	× (12.5%)
19	✓ (37.5%)	× (37.5%)
23	✓ (25%)	× (37.5%)
17	✓ (0%)	× (37.5%)
28	✓ (0%)	× (50%)
5	✓ (12.5%)	× (25%)
21	× (-25%)	× (50%)

Here we consider the question of why the stress contrast which is conditioned by syllable structure (or syllable weight) might be less easy to learn for L2 learners. One possible explanation is that sensitivity to phonological structure may decline with age. In fact, Guion, Harada, and Clark (2004) also show that among the three factors they investigated for stress assignment in English non-words, lexical class and phonological similarity but not syllable structure were significant factors for late Spanish learners of English, whereas all three factors were significant for early learners and native speakers.

3.3 Discussion

Our main interest was to establish whether there were any common characteristics shared by these 8 more native-like subjects which could explain their successful acquisition in assigning stress to English disyllabic and trisyllabic non-words. A

stepwise multiple regression analysis was run to examine the relationship between all L2 subjects' preference for penultimate stress on CVC penults and four other variables: Age, AOA, LOR, and Learning age. The criterion variable was all the L2 subjects' preference for the stressed CVC penult (in %) and the predictor variables were Age, AOA, LOR and Onset of English instruction. As summarized in Table 7, the procedure selected AOA as the factor that best predicts the Chinese subjects' preference for stress on CVC penults. None of the other factors made statistically significant contributions to accounting for the residual variance.

Table 7. Summary of stepwise regression analyses for the relation between L2 subjects' variables and the L2 subjects' preference for penultimate stress on CVC penults (N=20)

Variable entered	**B**	**SE B**	**Beta**
AOA	-2.593	0.673	-0.672*
Variables Excluded	Beta	*t*	*p*
Age	0.129	.538	0.597
Learning age	-0.029	-0.150	0.883
LOR	0.151	0.536	0.599

Note: *p<0.05

However, a high level of correlation was found between AOA and LOR (r=.774, p<.01), suggesting the possibility that the stepwise analysis erroneously rejected LOR from the model due to collinearity. This was because all but one of the subjects who arrived in the UK/US before or around puberty were also the youngest of our participants, studying in undergraduate programmes at the university; those participants who came to the UK/US for postgraduate programmes were older. To probe further into the relative effects of AOA and LOR, we ran a forced entry regression, and compared a model with only AOA as a predictor and model with both AOA and LOR as predictors. As summarized in Table 8, adding LOR increases R^2 by 0.009, but this change is not significant. A scatterplot of AOA against L2 subjects' preference is shown in Figure 3.

Table 8. Summary of forced entry regression analysis for the relation between two subject variables (AOA and LOR) and the L2 subjects' preference for penultimate stress on CVC penults (N=20)

Variable entered	B	SE B	Beta
Step 1			
AOA	-2.593	0.673	-0.672*
Step 2			
AOA	-2.143	1.085	-0.556
LOR	0.804	1.051	0.151

Note: R^2 =0.42 for Step 1; ΔR^2 =0.009 for Step 2 (n.s.). *p<0.05

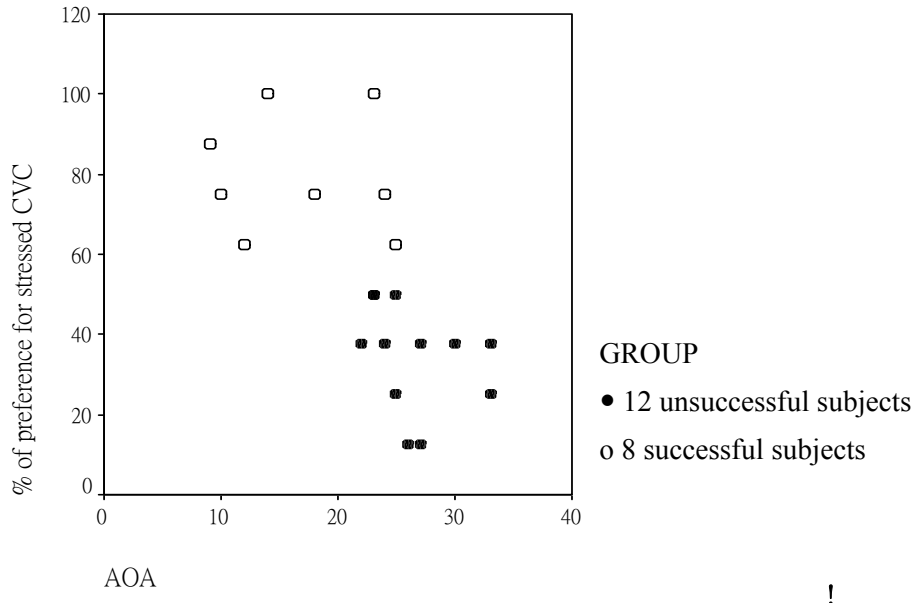

Figure 3. Relationship between L2 learners' stress preference for CVC and their age of arrival in the UK/US

As reviewed in Section 1, the effect of AOA is widely acknowledged in the literature, but previous research has produced somewhat mixed results on the effect of LOR, with studies disagreeing on whether a correlation can be found between LOR and the perceived foreignness of the L2 accent (e.g. Tahta, Wood, and Loewenthal 1981 and Riney and Flege 1998). Oyama (1976) claimed that AOA but not LOR could predict the degree of foreign accent. Piske, MacKay, and Flege (2001) argued that the discrepant findings on LOR effects can be unified under the interpretation that both LOR and AOA can be predictors at the early stages of L2 acquisition, but the effects of LOR taper off in later stages. This suggestion is plausible, because no matter how young L2 learners are when they arrive in the community of the target language, if they have not been exposed to the L2 long enough, their proficiency level cannot be particularly high. Our result fits the view proposed by Piske, MacKay, and Flege (2001): AOA is a better predictor of L2 learners' phonological proficiency after the earlier stages of L2 acquisition.

4. Conclusion

This study has shown that AOA and LOR are not only effective in predicting perceived global foreign accent in adult foreign language acquisition but also in predicting the successful acquisition of some very specific aspects of L2 phonology such as the domain of word stress. Such an understanding is important because L2 researchers need to know what particular aspects of L2 phonology contribute to a global foreign accent. What this study suggests is that part of a perceived foreign accent may result from non-native stress placement. In addition, our results also confirm that AOA serves a better predictor than LOR in predicting adults' foreign accent at the later stage of acquisition. Ideally, we should have gathered both perceptual and production data in the current study. However, due to the methodological limitations, we were only able to gather perceptual data. It is hoped that when the methodological problems are overcome an extensive study on production data can also be provided in order to bridge the gap between what the general understanding is about perceived foreign accent and the specifics of L2 stress assignment.

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Appendix: Non-words used in the experiment

Disyllabic non-words used in the preference task

Type 1: CV.CVCC (nouns)			Type 2: CV.CVCC (verbs)		
Visual stimuli	Auditory stimuli		Visual stimuli	Auditory stimuli	
	Final stress	Initial stress		Final stress	Initial stress
dosept	/dəsɛ́pt/	/dósɛpt/	zocept	/zəsɛ́pt/	/zósɛpt/
kasect	/kəsɛ́kt/	/kǽsɛkt/	vercept	/vəsɛ́pt/	/vɜ́rsɛpt/
fercept	/fəsɛ́pt/	/fɜ́rsɛpt/	dresect	/drəsɛ́kt/	/drǽsɛkt/
togest	/təgɛ́st/	/tógɛst/	magest	/məgɛ́st/	/mǽgɛst/
varect	/vərɛ́kt/	/vǽrɛkt/	vorect	/vərɛ́kt/	/vórɛkt/
bergest	/bəgɛ́st/	/bɜ́rgɛst/	nagest	/nəgɛ́st/	/nǽgɛst/
fermect	/fəmɛ́kt/	/fɜ́rmɛkt/	bozent	/bəzɛ́nt/	/bózɛnt/
shalent	/ʃəlɛ́nt/	/ʃǽlɛnt/	malect	/məlɛ́kt/	/mǽlɛkt/
Example of carrier sentences: The ___ is [blue/red/white/black/pink].			Example of carrier sentences: [He/She] is easy to ___.		

Trisyllabic non-words used in the preference task

Type 3: CV penult			Type 4: CVC penult		
Visual stimuli	Auditory stimuli		Visual stimuli	Auditory stimuli	
	́σσ	σ́σ		́σσ	σ́σ
natipa	/nǽtɪpə/	/nətípə/	bemfimpus	/bɛ́nfɪmpəs/	/bənfímpəs/
sebilka	/sɛ́bɪkər/	/səbíkər/	natimpa	/nǽtɪmpə/	/nətímpə/
panitus	/pǽnɪtəs/	/pənítəs/	vepilka	/vɛ́pɪlkə/	/vəpílkə/
pefira	/pɛ́fɪrə/	/pəfírə/	basilka	/bǽsɪlkə/	/bəsílkə/
terimy	/térɪmi/	/tərími/	tobitla	/tóbɪtlə/	/təbítlə/
tokifer	/tókɪfər/	/təkífər/	trufidla	/trúfɪdlə/	/trəfídlə/
varimi	/vǽrɪmi/	/vərími/	pemisto	/pɛ́mɪsto/	/pəmísto/
kabikus	/kǽbɪkəs/	/kəbíkəs/	natiskus	/nǽtɪskəs/	/nətískəs/
Example of carrier sentences: The ___ is [blue/red/white/black/pink].					

年齡因素和第二語言音韻特定系統的習得

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此篇論文探討年齡相關因素和第二語言音韻習得的問題。先前的研究多關心年齡因素和廣泛外國腔調程度的問題，本研究則是探討年齡因素和音韻特定系統的習得（即：英語字重音指派）的關係。利用英文假字指派字重音的實驗，我們比較英語母語人士和中文母語人士的表現，發現年齡相關因素不僅在預測廣泛外國腔調有效，而且對第二語言音韻特定系統（如：英語字重音系統）也有效預測。此外，到達年齡（AOA）的預測能力比居住長短（LOR）的預測能力來得強。結論是廣泛外國腔調有一部份是緣自非目標語的字重音指派形式。

關鍵詞：第二語言音韻習得、英語字重音習得、中英中介語