



The Effects of Explicit Rule and Acoustic-perceptual Instructions on Chinese ESL Learners' Prosodic Acquisition of English Lexical Stress

CHEN Hsueh Chu¹, TIAN Jing Xuan²

¹ The Education University of Hong Kong, Hong Kong

² The Education University of Hong Kong, Hong Kong

hsuehchu@eduhk.hk, xuanxuan1028123@msn.com

Abstract

Word stress has become one of the elements that English learners pay attention to because of its complexity and unpredictability. The main purpose of this study is to examine the effectiveness of two word stress instruction approaches, explicit rule instruction and acoustic-perceptual instruction. The study consists of five parts: pre-test, training, immediate post-test, introspective protocols, and delayed post-test. Forty Chinese learners of English were recruited and invited to read and listen 62 disyllabic and multisyllabic words in three tests. The participants were divided into two groups. However, 7 participants dropped out, and there are 33 participants (18 in the explicit rule instruction group and 15 in the acoustic-perceptual instruction group) in the current study. Normal stress rules were involved while the basics of Praat and the graphical representations were instructed to visualize the lexical stress. Overall, the participants' English word stress perception and production improved in both groups. Participants who received explicit rule instruction made significant improvements in the two post-tests. The improvement of the learners who received the acoustic-perceptual approach in the immediate post-test is not significant but is significant in the delayed post-test. The acoustic-perceptual approach takes time to produce a marked effect on word stress learning.

Index Terms: acoustic, stress rules, English word stress, prosody, second language acquisition

1. Introduction

Word stress, the pattern of stress within the boundary of a word, is one of the most important elements in English learning because inappropriate word stress affects intelligibility more seriously than segmental errors [1], [2]. However, word stress is complex and difficult for English learners to acquire because stress patterns for English syllabic structures and word affixes are unpredictable [3]. Even though some generalizations based on syllabic structures of words have been summarized, English learners whose first language (L1) is a tone-language (e.g. Chinese) find it is harder to acquire English stress than first language learners [4].

1.1. English Word Stress Instruction

Studies on English word stress have been conducted by researchers because word stress is of great importance in communication and listeners' comprehension [5]. Studies suggested that formal rules should be taught to English learners to draw on their explicit learning skills [6]. Nowadays, the development and use of acoustic phonetic analysis

software (e.g. Praat) provide clear visual cues to help learners improve their pronunciation accuracy [7]. Computer-assisted readings were applied to investigate the effects on pausing and lexical stress. Seventy-five ESL learners received a 13-week treatment, and results showed that the computer-assisted readings had a significant effect on learners' perception and production of lexical stress [8]. Task and procedural repetition have been implemented in teaching stress patterns [9]. Fifty-seven Korean high school students were examined through pre- and post-test. Both task repetition and procedural repetition were discovered to be effective in learning word stress, and task repetition has been proved to be more conducive to learning over time.

1.2. Acoustic Cues Application in Language Teaching and Learning

The use of visual prompts to support students' learning processes in language acquisition is well documented for both segmental and suprasegmental aspects of pronunciation learning [10]. Providing visual cues to students to help emphasize word stress, such as underlining, using bold or capitals, circling or using ticks may be routine [2]. A study involved 35 learners of Mandarin who underwent nine acoustic training sessions on Mandarin tones using Praat and suggests that acoustic analyses can be helpful as a complement to learners' Mandarin tonal learning [11]. A study was conducted to investigate the effectiveness of acoustic-aided Mandarin tone instruction. Six female Chinese learners participated in a study, and results show that participants successfully improved the accuracy of Mandarin tone pronunciation. The quality of Mandarin tone pronunciation except for Tone 3 in the first position of a disyllabic word and Tone 2 in the second position of a disyllabic word [12].

1.3. English Word Stress Rules Instruction

In L2 English classroom, learners acquire English lexical stress on a word-by-word learning strategy [13], using analogy, or internalizing teachers' explicit instruction of stress rules. Previous studies pointed out that word stress rules are highly recommended to teach English learners English word stress owing to the variance and less predictive patterns of English word stress [14]. English word stress rules, such as 'English stress tends to fall on syllables with longer vowels or when the word ends in two or more consonants' [15], are instructed. However, there are many exceptions to the word stress rules. Whether the application of word stress rules is effective for English word stress acquisition is still controversial. Phonological features, such as word stress, are not teachable because of the complex rules [16], and there is limited influence from explicit stress rules in the Hong Kong English

classroom. Stress rules are too complicated for L2 learners. Chinese learners seem to treat English stress the way they treat Chinese tone and are incapable of using the acoustic cues properly for word stress. Stress rules also seem too complicated for L2 learners to learn [17]. The application of lexical stress rules has been applied to be effective to teach 38 ESL learners [7], however, no delayed post-tests have been conducted to evaluate the long-term effects of the lexical rules' application. Also, there is only one group in this study, and no compared groups have been involved. Thus, the effectiveness of word stress rules instruction should be further investigated and compared.

Following the abovementioned studies, the current study was designed to investigate the effectiveness of the abovementioned two teaching approaches in English word stress.

2. Methodology

The current study aims to examine the short-term and long-term differences in English lexical stress production and perception before and after receiving explicit rule and acoustic-perceptual instructions. Thirty-three Chinese L2 English learners from a university in Hong Kong were recruited on a voluntary basis. There are five stages involved in the current study, namely, a pre-test, eight face-to-face explicit rule or acoustic-perceptual instruction sessions, an immediate post-test, introspective protocols, and a delayed post-test.

The materials used in the three tests were designed based on the same structure yet with different words. The 62*3 words were mainly chosen from the Graduate Examination Records (GRE) vocabulary. A production and a perception task aimed to measure participants' proficiency to correctly assign lexical stress to uncommon English words were assigned in the three tests. All participants read aloud each listed word in the sentence frame 'I said _ this time' continuously in the production task. The perception task involved the words as in the production task were shuffled in different orders and recorded by a native English speaker to examine whether the participants' perception of English stress placement was consistent with their production. The participants listened to the recording and indicated the syllable with primary stress.

All participants received an eight-session explicit rule instruction or acoustic-perceptual instruction. The teaching content of each session has been listed in Table 1 and Table 2. All participants learnt symbols and pronunciation of English consonants and vowels in the first session. Then, fifteen participants received seven sessions of explicit rule instruction, in which they learnt normal stress rules and how to use these rules or analyze syllabic structure, affixation, and vowel reduction to decode stress placement in an uncommon disyllabic or multisyllabic word. Another eighteen participants received acoustic-perceptual instruction, in which they learnt the basics of Praat, an acoustic analysis software, and used the software to analyze acoustic cues (e.g. pitch, intensity, duration, formants etc.) and visualize the lexical stress in uncommon English words.

In the post-tests, all 33 participants performed a production and a perception task to evaluate the effects of the two different instructional approaches. The immediate post-test was conducted one week after the training, and the

delayed post-test was conducted two months after the immediate post-test. Introspective protocols were assigned after the immediate post-test to investigate participants' self-reflections and comments on the training program they have attended.

Table 1: *The topics and content of the explicit rule instruction group.*

Topic	Content
IPA	<ol style="list-style-type: none"> 1. Symbols and pronunciation of English consonants and vowels 2. English vowel chart and articulatory knowledge
English word stress & Normal Stress Rule	<ol style="list-style-type: none"> 1. Concept of an English syllable and how to divide an English word into syllables 2. Normal stress rule in reading an unfamiliar word
Syllable structure patterns I	Syllable structure rule (verb)
Syllable structure patterns II	Syllable structure rule (noun)
Affixation patterns I	<ol style="list-style-type: none"> 1. Concepts of root and affixation 2. Stress patterns of words with different types of affixation
Affixation patterns II	<ol style="list-style-type: none"> 1. Concepts of compound nouns, compound adjectives, and long words 2. Stress patterns of compound nouns 3. Stress patterns of compound adjectives 4. Stress patterns of long words
Vowel reduction I	<ol style="list-style-type: none"> 1. Concept of primary stress 2. Concept of secondary stress 3. Concept of unstressed syllables
Vowel reduction II	<ol style="list-style-type: none"> 1. Concept of vowel reduction 2. Vowel reduction and full vowels comparison

Table 2: *The topics and content of the acoustic-perceptual instruction group.*

Topic	Content
IPA	<ol style="list-style-type: none"> 1. Symbols and pronunciation of English consonants and vowels 2. English vowel chart and articulatory knowledge
Praat basics	<ol style="list-style-type: none"> 1. How to locate, download, and listen to sample recordings of native English speakers' pronunciation of words 2. How to observe word stress using Praat 3. How to record themselves reading the same words, listen to their readings, and analyze word stress
Syllable structure patterns I	<ol style="list-style-type: none"> 1. Concept of an English syllable 2. How to divide an English word into syllables
Syllable structure patterns II	<ol style="list-style-type: none"> 1. Acoustic analysis on words with the same syllable structure 2. Regular and inconsistent word

		stress placement produced by a native speaker and the acoustic data with students' reading comparison
Affixation patterns I	1.	Concepts of root and affixation
	2.	Acoustic analysis on words with affixations produced by a native speaker and the acoustic data with students' reading comparison
Affixation patterns II	1.	Concepts of compound nouns, compound adjectives, and long words
	2.	Acoustic analysis on words with compound nouns, compound adjectives, and long words produced by a native speaker and the acoustic data with students' reading comparison
Vowel reduction I	1.	Concept of primary stress
	2.	Concept of secondary stress
	3.	Concept of unstressed syllables
Vowel reduction II	1.	Concept of formants of vowels
	2.	Acoustic analysis on words with vowel reduction produced by a native speaker and the acoustic data with students' reading comparison

3. Results

In general, the accuracy of identifying primary word stress placement in the perception tasks was significantly improved for all participants from both groups. The ANOVA results were significant, $F(2,42) = 4.518$, $p = .017^*$ (explicit rule instruction group) and $F(2,51) = 5.834$, $p = .005^*$ (acoustic-perceptual instruction group). The accuracy rate of the perception task for the participants who received explicit rule instruction raised from 80.73% in the pre-test to 89.88% and 89.06% in the immediate and delayed post-tests respectively as shown in Table 3. The perception task accuracy rate of the participants from the acoustic-perceptual instruction group also improved significantly from 77.48% in the pre-test to 87.86% and 87.82% in the immediate and delayed post-tests respectively.

Post hoc Tukey's HSD test was used to do pairwise comparison among the means of the three tests. For the explicit rule instruction group, results show that participants' accuracy rate in word stress placement perception tasks in both immediate and delayed post-tests, on average, were significantly higher ($M = 89.88\%$, $SD = 8.40$) ($M = 89.06\%$, $SD = 6.73$) than the accuracy rate in the pre-test ($M = 80.73\%$, $SD = 11.81$), $p = 0.025^*$ and $p = 0.045^*$, respectively. For the acoustic-perceptual instruction group, participants' accuracy rate in both post-tests, on average, were also significantly higher ($M = 87.86\%$, $SD = 9.10$) ($M = 87.82\%$, $SD = 11.05$) than the accuracy rate in the pre-test ($M = 77.48\%$, $SD = 11.22$), $p = 0.013^*$.

As for the production task, the accuracy rate for the participants who received explicit rule instruction raised from 70.93% in the pre-test to 78.50% and 79.05% as shown in Table 5. Participants who received acoustic-perceptual

instruction achieved 73.58% and 74.95% in the post-tests, with 4.44% and 5.81% improvement respectively.

Table 3: *The mean accuracy rate of perception tasks in three tests.*

Group	Pre-test		Immediate Post-test		Delayed Post-test	
	M	SD	M	SD	M	SD
Explicit Rule	80.73	11.81	89.88	8.40	89.06	6.73
Instruction	%		%		%	
Acoustic-perceptual	77.48	11.22	87.86	9.10	87.82	11.05
Instruction	%		%		%	

Table 4: *The mean accuracy rate of production tasks in three tests.*

Group	Pre-test		Immediate Post-test		Delayed Post-test	
	M	SD	M	SD	M	SD
Explicit Rule	70.93	7.84	78.50	6.94	79.05	6.99
Instruction	%		%		%	
Acoustic-perceptual	69.14	5.98	73.58	7.29	74.95	7.33
Instruction	%		%		%	

According to post hoc Tukey's HSD test results, explicit rule instruction group participants' accuracy rate in production tasks in both post-tests, on average, were significantly higher ($M = 78.50\%$, $SD = 6.94$) ($M = 79.05$, $SD = 6.99$) than the accuracy rate in the pre-test ($M = 70.93$, $SD = 7.84$), $p = 0.018^*$ and $p = 0.011^*$, respectively. For the acoustic-perceptual instruction group, the accuracy rate was statistically higher in the delayed post-test ($M = 74.95$, $SD = 7.33$) ($p = .038^*$) compared to the pre-test for production ($M = 69.14\%$, $SD = 5.98$).

Each participant participated in introspective protocols involved self-reflection on their own word stress acquisition experience on four aspects.

Phonological rules: conscious phonetic analysis and were characterized by the use of meta-language

The number of the provided phonetic or phonological rules in the explicit rule instruction group equaled 59 ($M=3.93$ per participant). The number of the provided phonetic or phonological rules in acoustic-perceptual instruction group equaled 46 ($M=2.56$ per participant).

- P2 (explicit rule instruction group): As for word stress English pronunciation, I think there are four rules altogether. The first one is for compound nouns, the first syllable carries the stress like "babysitter". No.2, for compound adjectives, the first syllable of the second word carries the stressed syllable like "world-famous". Rule3, if the word has prefix or suffix, and then both prefix and suffix carry no stress like "uncountable". Rule 4, as for 2-syllable words and 3-syllable words, the first syllable always carries the stress like "English".

Cross-linguistic influence: reports of perceived interactions between various active language systems

Reports of the phonological transfer from participants' mother language and other languages that they learned were involved in this section. Some participants indicated that their L1 (Chinese or dialects of Chinese) influence their English word stress acquisition.

- P7 (explicit rule instruction group): I think Chinese has an effect on word stress in English, although it hasn't got word stress. There are 4 tones in Chinese. Tone 4 (the falling tone) sounds like that it carries the stress as well, as is normally produced with high sound intensity and power. I can hardly differentiate between primary stress and secondary stress unless the stressed syllable is produced particularly prominently. From my perception, they are stressed equally.
- P1 (acoustic-perceptual instruction group): My L1 affects stress. When you started learning English without any basic knowledge, learning relatively depends on your L1. So when speaking in English, unconsciously I will add this accent to the words.

Self-report: the participants' general statements about the process of learning pronunciation

According to the results of the introspective protocols, eleven out of 15 participants in the explicit rule instruction group feel that word stress rules are complex and cannot be applied to every word, but they will teach word stress rules or instruct word stress rules as supplement in their future teaching to help their students acquire English word stress.

- P7 (explicit rule instruction group): I think it is helpful to determine the primary stress based on the specific structure of the words, such as words with affix and compound words, or on the part of speech, like noun or adjectives. I think it is helpful to determine the primary stress based on the specific structure of the words, such as words with affix and compound words, or on the part of speech, like noun or adjectives.
- P8 (explicit rule instruction group): If I am a teacher to teach word stress, I will introduce students some common rules and guide them to apply the rules to the frequently-used words in the textbook to cultivate their awareness. Though the rules can't be apply (applied) to every word, in their learning stage right now those can be enough.

Self-observation: explanations of specific language behavior

Fifteen out of eighteen participants in the acoustic-perceptual instruction group hold the opinion that the acoustic-perceptual instruction is beneficial, useful, and effective for their English word stress learning. Visualized cues have been provided, and they can know the gaps between their own production with the native speaker's speech. Two participants' introspective protocols from the explicit rule instruction group have been listed as examples.

- P2 (acoustic-perceptual instruction group): I think that learning word stress using Praat is effective, which help me immediately get the number and help me improve, because generally if we listen to the word we know which syllable is stressed, but if you want to be more specific and improve more and explain to other people with data or with some visualize thing to help people understand Praat is really effective and objective.
- P4 (acoustic-perceptual instruction group): Praat effectively makes comparison by visualizing of my

reading and native speakers' reading and I can see the differences between them. I think Praat is useful and I will use it for research purposes, but I may not use it for daily learning.

4. Discussion

The effectiveness of the application of the two English word stress instruction approaches (explicit rule instruction and acoustic-perceptual instruction) was explored in the three tests in terms of accuracy rates.

Participants' performances in the explicit rule instruction group made improvements in both perception and production tasks in the post-tests, which is in line with Sadat-Tehrani [7]. Explicit rule instruction is not only effective in short-term word stress learning but also their performances retained in the long-term. However, participants' performances in the acoustic-perceptual made improvements in perception tasks in the post-tests. The improvements in production tasks of the immediate post-test is not as significant as the performances in the delayed post-test. Acoustic-perceptual instruction helped learners to improve gradually, and it takes time. The reason is likely to be that the software Praat applied in this approach is technical and professional, and learners need to spend some time learning how to use the software to analyze and compare the values of their production with native speaker's.

The results of introspective protocols show that the two teaching approaches are effective from the learners' perspectives. Even though word stress rules cannot be applied to every word, it is still effective and useful, which is contrary to Jenkins [16]. Word stress rules are complicated, but it is teachable and there is a great chance for learners to put correct stress placement in an uncommon word but consistent with the rules they learned. However, participants in both groups make errors in different patterns. Words which are both consistent and inconsistent with word stress rules taught in the explicit rule instruction were selected in the three tests. More participants in the explicit rule instruction group made errors in the words which are inconsistent compared with participants in the acoustic-perceptual instruction group. The findings can help develop effective English word stress training schemes for L2 English learners.

5. Conclusions

This study explored the effectiveness of two types of word stress instruction approaches, explicit rule instruction and acoustic-perceptual instruction, and evaluated the effectiveness from the learners' points of view. Generally speaking, the participants who received explicit rule instruction improved and retained in perception and production tasks. The participants in acoustic-perceptual instruction group significantly improved and retained in perception tasks but showed no significant improvement immediately after the training, but the improvements are obvious after two months. Participants' L1 influences their English word stress acquisition, and the vast majority of participants in both groups stated that the instruction approach they received is effective. The two training approaches have significant implication on the word stress teaching and learning.

6. References

- [1] Z. Bond, *Slips of the ear: Errors in the perception of casual conversation*. San Diego, CA: Academic Press, 1999.
- [2] A. Cutler and C. F. Clifton, "The use of prosodic information in word recognition," *In Attention and Performance x: Control of Language Processes*, pp. 183-196. Hillsdale, NJ: Lawrence Erlbaum 1984.
- [3] R. Roach, *English phonetics and phonology: A practical course (4th ed.)*. Cambridge, England: Cambridge University Press, 2009.
- [4] J. Archibald, "The acquisition of English stress by speakers of nonaccentual languages: Lexical storage versus computation of stress," *Linguistics*, vol. 35, pp. 167-181, 1997.
- [5] N. Sadat-Tehrani, "Teaching English Stress: A Case Study," *TESOL Journal*, vol. 8, no. 4, pp. 943-968, 2017.
- [6] C. Dalton and B. Seidlhofer, *Pronunciation*. Oxford: Oxford University Press, 1994.
- [7] H. Lin, C. Fan, and Chen, C. *Teaching pronunciation in the learner-centred classroom*. ERIC Document Reproduction Service No. ED393292, 1995.
- [8] M. Tanner and M. Landon, "The Effects of Computer-Assisted Pronunciation Readings on ESL Learners' Use of Pausing, Stress, Intonation, and Overall Comprehensibility," *Language Learning & Technology*, vol.13, no. 3, pp. 51-65, 2009.
- [9] L. Gurzynski-Weiss, A. Long, M. Solon, Y. Jung, Y. Kim, and J. Murphy, "The Role of Task Repetition in Learning Word-stress Patterns Through Auditory Priming Tasks," *Studies in Second Language Acquisition*, vol. 39, no. 2, pp. 319-346, 2017.
- [10] D. M. Hardison, "Acquisition of second-language speech: Effects of visual cues, context and talker variability," *Applied Psycholinguistics*, vol. 24, pp. 495-522, 2003.
- [11] D. Chun, Y. Jiang, J. Meyr, R. Yang, "Acquisition of L2 Mandarin Chinese tones with learner-created tone visualizations," *Journal of Second Language Pronunciation*, vol. 1, no. 1, pp. 86-114, 2015.
- [12] H. C. Chen and Q. W. Han, "The Effectiveness of Acoustic Training on Tone Acquisition by Hong Kong Learners of Mandarin," *Proceedings of the International Congress of Phonetic Sciences ICPhS*, pp. 1957-1961, 2019.
- [13] S. G. Guion, "Knowledge of English stress in second language learners: First language and age of acquisition effects," *Korean Journal of English Language and Linguistics*, vol. 6, pp. 465-492, 2006.
- [14] C. Dalton and B. Seidlhofer, *Pronunciation*. Oxford: Oxford University Press, 1994.
- [15] N. Chomsky and M. Halle, *The sound pattern of English* (Paperback reprint 1991). Cambridge, MA: MIT Press, 1968.
- [16] J. Jenkins, "A sociolinguistically based, empirically researched pronunciation syllabus for English as an international language," *Applied Linguistics*, vol. 23, pp. 83-103, 2002.
- [17] H. C. Chen, "Chinese learners' acquisition of English word stress and factors affecting stress assignment," *Linguistics and Education*, vol. 24, pp. 545-555, 2013.