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Introduction

Pronunciation instruction is not often provided in English as a foreign language (EFL) classrooms (Derwin & Munro, 2015). Even if it is provided, the time spent during a class is short and sporadic (Huensch, 2019). Under these circumstances, the limited opportunities for teaching pronunciation tend to be spent on explicit instruction, in which the teacher typically explains how to articulate a target sound and has the learners try to articulate it. The learners are forced to produce a new sound after listening to a model sound for a limited time.

There is an issue that can be named the "present-practice-done approach." First, the modeling of sounds is usually limited to one or two times, which is not sufficient for enabling learners to create an acoustic image of a target sound. Second, the model sounds are usually recorded by a limited number of speakers. In the era of English as a lingua franca (ELF), ideally second language (L2) learners would be provided with input from a variety of speakers with differing accents and then create a common acoustic image of the target sound. Third, the frequency of practice is also limited. When pronunciation is featured sporadically during reading aloud after comprehension of a text, for example, the learners have few chances to say the sound aloud. It would be effective if they had more chances to say aloud a target sound. Finally, the method of instruction is typically an oral explanation of how to articulate a sound and is supplemented with a picture of a mouth or gestures of how to move one's mouth and tongue. The use of videos as

visual aids could be an effective option if a close-up image of a speaker's mouth was shown.

To address the issues described above, high variability phonetic training (HVPT) has been reported to be effective in improving L2 learners' perception and production of target sounds (Thomson & Derwin, 2014). To improve L2 articulation, particularly in EFL classroom situations, explicit instruction that includes the repetition of sounds could provide learners with appropriate articulatory images.

Wiener, Chan, and Ito (2020) investigated the effects of HVPT with explicit instruction on perception and production of L2 Mandarin contours in variable and non-variable conditions. Perception and production were measured before and after instruction. The results indicated HVPT did not solely improve the perception and production of the target sounds, but together with explicit instruction, it showed positive effects, suggesting that HVPT is more beneficial when it is coupled with explicit instruction.

Iino, Yabuta, and Wistner (2020) examined the effects of using HVPT with the condition that learners were instructed to repeat after every stimulus sound. Even though the three target consonants, /l/, /r/, and /w/, were relatively difficult phonemes for Japanese learners of English to perceive and pronounce accurately, after a 10-week intervention, the participants' production of the segmental sounds improved more than the gains reported from perception training only in Iino (2019).

Thus, the present study investigated the effects of HVPT with explicit instruction on L2 perception and production of three relatively difficult phonemes for Japanese learners of English: /l/, /r/, and /w/. The difference from Iino, Yabuta, and Wistner (2020) was the additional treatment of explicit articulation instruction, following the approach used by Wiener et al. (2020). Also, instruction aimed at raising learners' consciousness of the articulations of the target sounds along with shadowing practice were provided often in the regular classroom periods. Hence, the following research questions were posited:

RQ1: To what extent does HVPT with explicit articulation instruction affect L2 learners' perception of the target sounds?

RQ2: To what extent does HVPT with explicit articulation instruction facilitate the production of the target sounds?

RQ3: To what extent do L2 learners perceive the use of English Accent Coach, combined with explicit instruction, as facilitative for improving their perception and production of L2 English sounds?

Method

Participants

Fourteen university freshmen participated in this study. Their first language was Japanese, and they studied English as a foreign language in a university in Tokyo. Their English proficiency level was in the band of CEFR A2, based on TOEIC listening and reading test results (M = 440, SD = 66).

HVPT materials

English Accent Coach (EAC; Thomson, 2017) was used to provide the participants with HVPT. EAC is a cloud-based gamified program open to the public for phonemic perception training. The purpose of HVPT is to assist learners in building robust acoustic images of a variety of accents in English. The stimuli consist of a variety of English accents and are presented randomly. For data collection, a forced-choice identification task was adopted, in which the participants listen to the stimuli and select one of the target phonetic symbols shown on the display (i.e., /l/, /r/, /w/). After each response, immediate feedback regarding the accuracy of the answer is provided visually. If the choice was incorrect, the user must choose the correct symbol to correct the mistake. After completing 200 stimuli, the success rate is displayed as a percentage for each targeted phoneme, which makes it easy for the learners to assess their progress.

Instructional treatment

During the instructional period, the participants completed three sessions of EAC per week in which they completed forced-choice identification tasks (see Table 1). One training session consisted of 200 stimuli with the target sounds of /l/, /r/, and /w/ delivered as initial consonants in the conditions of CV (consonant + vowel) or CVC (consonant + vowel + consonant). Every other week, the participants completed the training under CV or CVC conditions alternately.

For explicit instruction during Week 1, the website "a-i-u-e-o phonics" (https://aiueophonics.com/) was utilized. This site provides simple and easy explanations of articulatory points based on a phonics approach. Other videos that showed the mouth movements for /l/, /r/, and /w/ (Sozo Exchange, 2014), which are also freely available online, were shown to the participants in Week 1 (Appendix 1). Additionally, links to the articulation videos were made available

Table 1. Research procedure

<table>
<tr><th></th><th>Perception</th><th>Production</th><th>Explicit Instruction</th></tr>
<tr><td>Pre-tests</td><td>EAC 100 stimuli in CV 100 in CVC</td><td>Carrier sentence method: 9 CV+18 CVC</td><td></td></tr>
<tr><td>Week 1</td><td>EAC training with 200 stimuli in CVC: target C + all V+C</td><td rowspan="6">Repeat after stimuli during EAC three times a week</td><td>Explanation on how to articulate /r/ and /l/ with the online video of the mouth movements</td></tr>
<tr><td>Week 2</td><td>EAC 200 stimuli in CV: target C + /a/</td><td rowspan="5">Links for the videos were available through the course LMS

Shadowing practice with consciousness raising, including comments by the instructor</td></tr>
<tr><td>Week 3</td><td>EAC 200 stimuli in CVC: target C + all V+C</td></tr>
<tr><td>Week 4</td><td>EAC 200 stimuli in CV: target C + /a/</td></tr>
<tr><td>Week 5</td><td>EAC 200 stimuli in CVC: target C + all V+C</td></tr>
<tr><td>Week 6</td><td>EAC 200 stimuli in CV: target C + /a/</td></tr>
<tr><td>Post-tests</td><td>EAC 100 stimuli in CV 100 in CVC
Questionnaire on using EAC</td><td>Carrier phrase method: 9 CV+18 CVC</td><td></td></tr>
</table>

through the course LMS.

The participants also practiced shadowing, using the passages in a textbook during their regular classes every week. Shadowing was introduced as an activity to say aloud the listening text based on the model sounds. During the practice, the instructor reminded the students to pay attention to the target sounds in the text as much as possible.

Pre- and post-tests

Before and after the six-week instructional period, the participants took pretests and post-tests (perception and production). Each test consisted of 100 stimuli with the three target consonants /l/, /r/, and /w/ presented equally in the CV and CVC conditions. The tests were conducted in EAC using a customized test function.

The perception test consisted of 30 to 35 items randomly presented per target phoneme out of 100 stimulus sounds. Specifically, one target phoneme was presented at the beginning of each stimuli sound, and the pattern of the subsequent phoneme environment was changed to a CV with a short stimulus sound and a CVC with a short syllable word, so three target phonemes were randomly selected. Participants' correct answer rate was used as a measure of perception.

The production test used the carrier phrase method in which a recording containing the target phoneme was embedded in the carrier sentence and presented. This is a method in which the stimulus voice is embedded in the X part of the sentence. When "Next word is X." is presented orally, the learner who hears it speaks in the form of "Now I say X." For example, when they hear "Next word is ra.", they immediately speak in the form of "Now I say ra." Since this is a task requiring a cognitive load rather than simply repeating the target phoneme, it is said to be suitable to see if the phoneme has been acquired (Thomson, 2011). Participants used headphones with a microphone and recorded 27 sounds (9 sounds in CV environment, 18 sounds in CVC environment). The recorded data were assessed by three raters: one Japanese English teacher and two American English

teachers who had taught English at the university level for more than 10 years. The evaluation was performed by selecting which sound was heard. If any discrepancy occurred in the judgements, the raters discussed and decided if the sounds were acceptable or not. The adjusted intra-class correlation coefficient was .78, which was an acceptable level.

Results

RQ1: To what extent does HVPT with explicit articulation instruction affect L2 learners' perception of the target sounds?

The descriptive statistics for perception are shown in Table 2. The total means of the three target sounds in both the CV and CVC conditions increased by 12 points from the pre-test to the post-test, which was statistically significant ($t(13) = 3.06$, $p < .01$, $d = 1.15$). However, that increase was not as high as the results reported in Iino et al. (2020).

The difference in the linguistic environment surrounding the target sounds showed obvious differences. In particular, the 14-point increase observed in the CVC condition was statistically significant ($t(13) = 3.20$, $p < .01$, $d = 1.37$), while the10-point increase observed in the CV condition was not statistically significant ($t(13) = 2.06$, *n.s.*, $d = 0.69$). These results revealed the contribution of the gains from the CVC condition to the participants' overall development in perception of the target sounds.

When the progress of each sound was examined, /r/ in the CVC condition showed the largest improvement (26 points, $t(13) = 4.07$, $p < .001$, $d = 1.57$). Perception of /l/ increased significantly in both conditions. However, it was found that the achieved level was higher in the CVC condition (see Figure 1).

Table 2. Descriptive statistics for perception and the results of the *t*-tests

Perception		Pre	*SD*	Post	*SD*	+	*t*	*p*	*d*
CV	l	62	18.0	78	20.1	16	3.02	0.01	0.87
	r	52	19.6	61	28.4	9	1.34	0.20	0.4
	w	92	16.4	98	2.7	6	1.50	0.16	0.55
	Total Mean	69	14.5	79	14.2	10	2.06	0.06	0.69
CVC	l	77	15.4	94	6.2	17	3.55	0.00	1.5
	r	57	20.3	83	13	26	4.07	0.00	1.57
	w	91	17.1	98	2.4	8	1.60	0.13	0.65
	Total Mean	80	14.5	94	4.9	14	3.20	0.01	1.37
CV+CVC	Total Mean	74	13.2	86	7.4	12	3.06	0.01	1.15

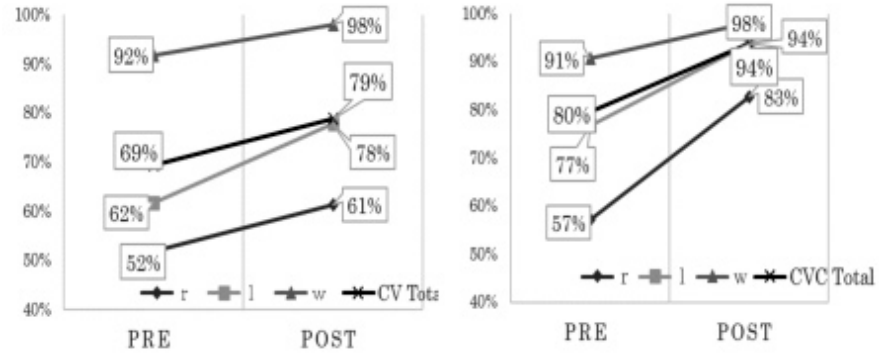

Figure 1. Perception progress in CV condition (Left) and in CVC condition (Right)

RQ2: To what extent does HVPT with explicit articulation instruction facilitate the production of the target sounds?

Based on the descriptive statistics (Table 3), the total mean of CV and CVC showed an increase of 10 points, which was not significant ($t(13) = 2.11$, $p = .55.$, $d = 0.46$). While the progress in CV was also not significant, the 12-point increase in the CVC total was significant ($t(13) = 2.70$, $p < .05.$, $d = 0.51$). The largest progress was made for /l/ in CVC ($t(13) = 2.48$, $p < .05$, $d = 0.61$) (Figure 2).

In the CV condition, no significant progress was observed. The smallest increase was in /w/ since it exhibited a high level of accuracy on the pretest. In

terms of achievement levels, progress for /l/ was relatively lower compared with /r/ and /w/. Generally, achievement levels showed a similar tendency in both conditions.

Table 3. Descriptive statistics for perception and the results of the *t*-tests

Production			Pre			Post			Gain Score				
		No. of Stimuli	*M*	*SD*	%	*M*	*SD*	%	+	*t*	*p*		Cohen's *d*
CV	l	3	0.43	0.76	14	0.86	1.03	29	14	1.19	.254		0.49
	r	3	1.36	1.01	45	1.5	0.85	50	5	0.49	.635		0.16
	w	3	2.71	0.61	90	2.71	0.83	90	0	0	1		0.00
	Total	9	4.57	1.74	51	5.07	1.9	56	6	0.56	.585		0.2
CVC	l	4	0.79	1.31	20	1.64	1.6	41	21	2.48	.028	*	0.61
	r	5	1.57	1.28	31	2.29	1.82	46	14	1.68	.117		0.47
	w	5	3.93	1.38	79	4	1.18	80	1	0.27	.793		0.06
	Total	14	6.29	3.15	45	7.93	3.5	57	12	2.7	.018	*	0.51
CV+ CVC	Total	23	10.79	4.85	47	13	5.04	57	10	2.11	.055	+	0.46

Note. *$p < .05$.

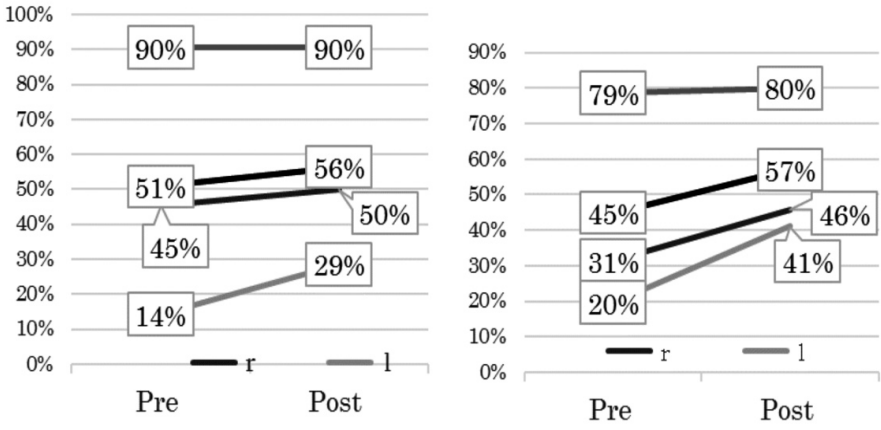

Figure 2. Perception progress in CV condition (Left) and in CVC condition (Right)

RQ3: To what extent do L2 learners perceive the use of English Accent Coach, combined with explicit instruction, as facilitative for improving their perception and production of L2 English sounds?

Regarding the use of EAC in general, the majority of the participants responded positively with over 50% choosing "4 Fairly agree" and "5 Strongly agree" for each of the first three questions. It was found that the majority of the participants perceived the use of EAC as easy and fun as well as being willing to use it more to learn pronunciation (No. 15, Figure 3).

Although HVPT provided in EAC caused confusion for 88% of the participants (No. 5 & 6), the variation of the sounds was perceived by 74% (No. 4). Additionally, the linguistic condition caused the differences in perception (81% on No. 7).

In total, 63% of the participants perceived that their phonemic perception of the target sounds had improved (No. 10). They also recognized that effective target sound perception positively influenced the perception of other phonemes (56% on No. 11) and even listening skill in general (63% on No. 12).

As for production, 25% responded that they became able to produce the target sounds correctly (No. 13), while 69% answered they were not sure if they had become able to.

In terms of the reaction to the explicit instruction on the target phonemes, repeating stimuli aloud was practiced by 69% (No. 8); the links to the articulation videos on the LMS site were used by 19% of the participants (No. 9).

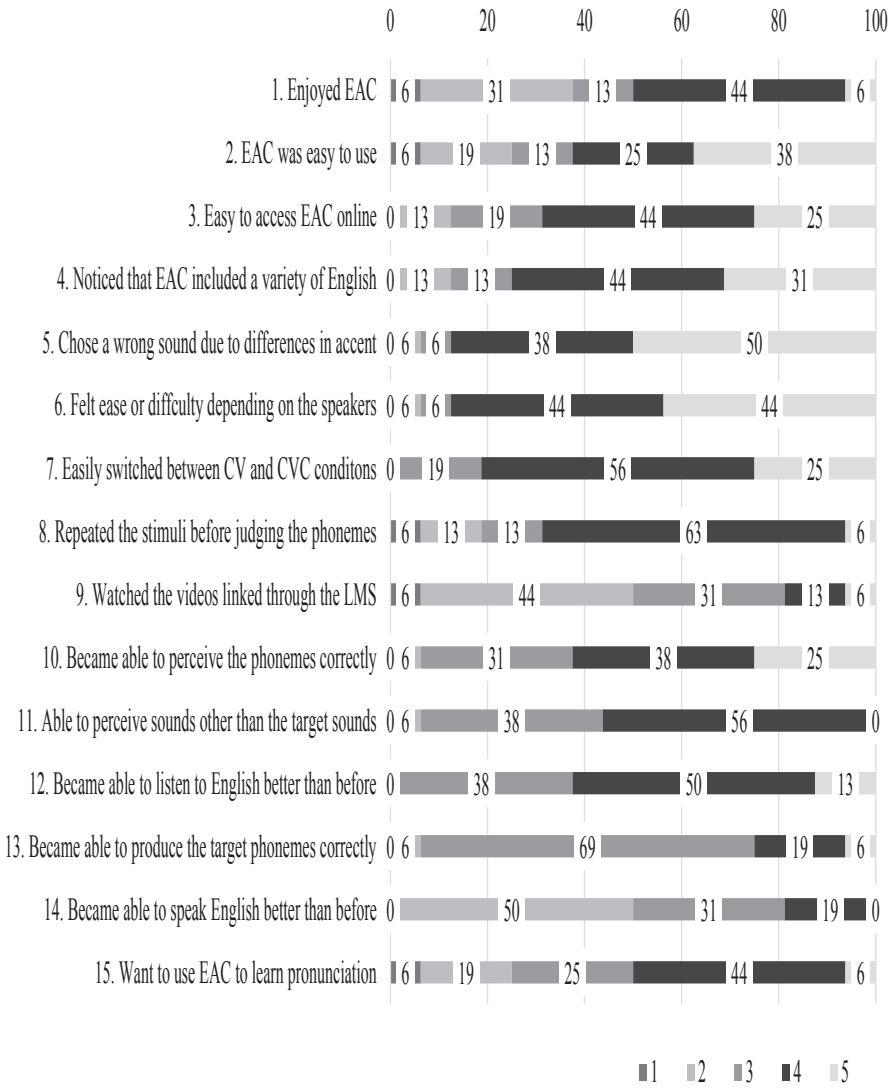

Figure 3. Reactions to the use of EAC

Discussion

In terms of improvement in perception skills, the progress made in six weeks seems sufficient when compared with the 10-week intervention reported in Iino, Yabuta, and Wistner (2020). Additionally, considering the level of the participants' L2 proficiency which was lower (TOEIC, M = 440) than that in Iino et al. (TOEIC, M = 579), perception skills were successfully trained intensively with the help of EAC regardless of the leaners' proficiency level. From the result that a majority of the participants noticed the difficulties caused by the high variability of the speakers, the use of computer assisted intensive HVPT with English Accent Coach seems to have nurtured the creation of robust acoustic images of the target sounds.

While the improvement of perception was almost the same as in Iino et al. (2020), the progress in production was smaller than expected. This result may have come from the shorter length of the treatment (i.e., six weeks compared to 10 weeks in the previous study).

It was also interesting to find that /r/ was produced more accurately than /l/ in both CV and CVC conditions. This tendency was not observed in Iino et al. (2020), in which the initial explicit instruction on the target sounds consisted of articulation videos and the encouragement to repeat after stimuli sounds. The results of the current study may have come from the explicit instruction, in which the instructor directed learners to pay attention to /l/ and /r/ sounds before shadowing practice during regular class periods. In addition to providing the videos at the beginning of the training period, making the links to the videos available for self-access might have also contributed to the learners' progress in /l/ and /r/ discrimination and production.

However, as the frequency of using self-access links to the articulation videos was relatively low, the positive effect on /r/ perception and production might have resulted from the classroom explicit instruction. Furthermore, the relatively low achievement on /l/ might be from learners' overgeneralization of /r/ to it, though

a detailed error analysis may be needed in the future to clarify this.

These findings suggest that the mixture of explicit instruction and a large amount of HVPT with pushed output instruction through shadowing might have facilitative effects on production, albeit partially and slowly.

Regarding the questionnaire results, it was found that EAC was easy and fun for the learners to use. It also made them feel eager to use it when learning the pronunciations of sounds in the future. These results point to the potential of computer assisted phonetic training, which also saves time for in-class intensive pronunciation training and expands it outside of class easily.

One of the most significant findings was that most of the learners noticed the different accents of the speakers and found difficulty in judging the sounds. Nevertheless, they made progress in developing their perception skills. The strength of EAC seems to be in its provision of a variety of accents in an intensive manner.

As for production of the sounds, the perceived improvement in production was low, which corresponded with the low progress in the production rates in general. In terms of the reaction to the use of videos, which was infrequent and a possible cause for the low levels of improvement in production, the results could be caused by the possibility that the participants repeated the sounds mechanically without paying much attention to how to articulate the sounds right after clicking the answers.

Conclusion

This six-week study clarified the positive effects of the computer assisted HVPT intervention, which included explicit articulation and shadowing instruction, on L2 learners' target sound perception. Regarding production, statistically significant improvement was observed for only one of the sounds in a certain linguistic environment. The outcomes seem to have been corroborated by the learners through the questionnaire results. Thus, HVPT combined with explicit instruction

can positively affect L2 learners' perception and pronunciation in EFL situations.

The following limitations could have affected the results of the present study. First, the explicit instruction consisted mainly of suggesting or asking the participants to repeat after the stimuli sounds. Adapting this part of the instruction so that the learners process the sounds more deeply before repeating them could improve the effectiveness of the instruction. Second, the instructional sequence of viewing articulation videos and shadowing could be made more systematic. Follow-up activities for the articulation videos could be incorporated, and target sounds could be highlighted in the text when shadowing. Also, pair work could be implemented in the shadowing phase to check the accuracy of the sounds in an interactive way. Finally, the length of the instructional period could be lengthened to enhance the overall effectiveness of the instruction.

Notwithstanding these limitations, the combination of explicit instruction and HVPT has a strong potential to improve L2 learners' pronunciation both in perception and production in EFL environments.

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Appendix 1. Screen capture of the articulation for the word *rarely* by a native English speaker (Sozo Exchange, 2014).